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China Report

SCIENCE AND TECHNOLOGY

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CHINA REPORT

SCIENCE AND TECHNOLOGY

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PEOPLE'S REPUBLIC OF CHINA

ABSTRACTS

NATIONAL DEVELOPMENTS

GOVERNMENT TO DOUBLE SCIENCE RESEARCH FUNDS

OW101236 Beijing XINHUA in English 0819 GMT 10 Apr 86

[Text] Beijing, 10 April (XINHUA)--The China State Natural Science Foundation will soon begin accepting applications for funds from research workers throughout the country, the Foundation Committee announced here today.

The Foundation Committee, headed by leading chemist Tang Aoqing, was launched in February this year.

The foundation's funds mainly come from the state and also from units and individuals at home and abroad.

The total amount of funds available this year, according to the committee, will be twice as much as usual, but no specific figures were given.

All scientific workers in China will be eligible to apply for grants from the fund, the committee said.

The committee said that it will give priority to important basic and applied research projects which are likely to aid China's modernization drive, develop new technologies and promise positive results within 3 to 5 years.

The foundation also encourages research cooperation between different institutes, departments and regions.

It is particularly keen to promote scientific development and train personnel for remote underdeveloped areas.

The grants will be reviewed by a panel of experts organized by the foundation.

Formerly, the state appropriated funds for research to the research organizations and no individual application was accepted.

/12232
CSO: 4010/2014

NATIONAL DEVELOPMENTS

GAIN IN WORLD PRESTIGE SEEN IN HIGH-TECH DEVELOPMENT

OW051552 Beijing XINHUA in English 1512 GMT 5 Apr 86

[Text] Beijing 5 April (XINHUA)--China should speed up its development of high-technology sectors of the economy, today's ECONOMIC INFORMATION said in a commentary.

In the past two years, it said, the United States, the Western European countries and the Comecon countries have worked out plans focussing on the development of high technology. The plans have shown that a new bout of fierce competition in the high technology field has started among the United States, the Soviet Union and the developed countries in Western Europe, the commentary said.

Many factors show that the development level of high technology indicates the actual strength of a country, and affects its political prestige and status in the world, the commentary emphasized.

Chinese Premier Zhao Ziyang said two years ago that China should study developments in new technology worldwide and work out measures to keep up with the trend. He pointed out that, to China, this is a challenge and also a chance.

In the past two decades, the commentary said, China has made atomic bombs, missiles and satellites. This has greatly raised China's position in the world. It said China has trained seven million scientists and technicians and over ten million skilled technical workers. They have achieved great advances in the high-technology field and a number of advanced research institutions and facilities have been constructed.

This is a good foundation for China to develop its technology further, the commentary said. It continued that China will surely be able to catch up with the developed countries in the high-technology field if sufficient efforts are put into this sector in the next few years.

"Economic Information" also reviewed China's achievements in the devleopment of technology in the past few years, covering micro-electronics, telecommunications, biological, space, nuclear, laser, remote sensing, new materials and superconduction technologies.

In recent years, China has built large and super large-scale computers which have capacities of up to 100 million operations per second.

In the space industry, China can manufacture large-scale carrier rockets and satellites of different types, and has launched 18 man-made satellites. China was maong the first countries to use laser techniques for medical purposes.

Since the late 1950s, China has developed more than 10,000 varieties of new materials and established a number of research institutes, test sites and production centers.

/12913
CSO: 4010/2015

IMPORT OF HIGH TECHNOLOGY TO BE GIVEN PREFERENCE

OW112052 Beijing XINHUA in English 2005 GMT 11 Apr 86

[Text] Boston, 10 April (XINHUA)--A leading Chinese industrial official said here today that in the next five years China would give preference to the import of high technology to boost its economic development.

Speaking at a seminar on technology transfer and business management at the Massachusetts Institute of Technology, Sun Zonghao, deputy leader of the Chinese Economic Management Delegation, said the items to be imported include software, key equipment, basic technology and technical know-how for producing raw materials, basic parts, and components.

The delegation, led by Yuan Baohua, vice minister in charge of the State Economic Commission, is on a tour of the United States at the invitation of the National Committee on U.S.-China Relations.

Sun, director of the Bureau of Enterprise Renovation, the State Economic Commission, continued that another means of introducing foreign technology to China is to start joint ventures with overseas partners. Such ventures covering a period of more than ten years would be exempted from income tax in the first and second profit-making years and allowed a 50 percent reduction in income tax in the third through the fifth years.

In addition Sun said, if investors provide high technology and equipment, a certain proportion of the products may be sold in China.

He told the seminar participants that over the last five years, China completed 200,000 projects of technological transformation, with most related to installation of new production lines and key equipment.

China's cooperation with foreign investors and industrialists has grown steadily over the years. By the end of last year, the country had 2,300 joint ventures, 3,700 enterprises of cooperative management and 120 exclusively foreign-owned firms.

A heated discussion followed his presentation. Responding to a question on how technology imports were handled in China, Sun Zonghao explained that at present any import worth more than five million dollars would be approved by

the central government, whereas any sum less than this would be a matter of decision by departments concerned or local authorities.

In reply to another question on foreign currency remittance by overseas business partners, he said any foreign investor or businessman in a joint venture, producing goods of special needs to the Chinese market would have no difficulty in receiving his earnings in foreign currency, if such arrangement was specified in agreement with the approval of the Chinese government.

Attending the 2-day seminar are U.S. and Chinese officials, business executives and industry management specialists. The meeting will continue tomorrow.

/12913
CSO: 4010/2015

NATIONAL DEVELOPMENTS

HONG KONG FIRM TO PROTECT PRC INVENTIONS SOLD ABROAD

HK010722 Hong Kong SOUTH CHINA MORNING POST (BUSINESS NEWS supplement) in English 1 Apr 86 p 1

[By Paul Sham]

[Text] China Patent Agent (GH) Ltd is to raise US$10 million in Hong Kong from local and foreign sources to protect innovations sold abroad by China's emerging industries.

Liu Gushu, the company's first deputy chairman and general manager, told BUSINESS NEWS the fund will be used largely to pay patent application fees in countries where Chinese technologies are expected to be competitive.

China Patent will not only assist companies who have neither the expertise nor the hard currency to make patent applications alone, but will also help to market promising products. Details of the money-raising have yet to be worked out, but the money pool will form an investment fund similar to those in Hong Kong, Mr. Liu said. "It will be a combination of business to tap the market potential of China's technology overseas and contribute to boosting the country's foreign exchange earnings."

China Patent was originally appointed by China's State Council to receive applications for registration of patent rights and trade marks from foreign firms in China. Its planned wider role has been prompted by expected good demand for Chinese inventions and the need to ensure they are adequately protected.

An allotment of US$500,000 to China Patent early this year to apply for foreign patent applications has already been used, and the company is to invest an equal amount in the second half.

The 20 Chinese innovations so far in line for patent protection include a power generator, transmission device, and teaching and X-ray equipment.

According to a recent report by INTERNATIONAL BUSINESS, a Beijing-based trade journal, China has signed more than 30 outbound technology transfer agreements with other countries since 1980. Their total value was US$10 million.

During the technology fair held at Birmingham last October, about 20 of the 29 inventions and processes exhibited by China resulted in signed agreements or letters of intent with foreign companies. By the end of last year, China had registered 20,000 local innovations, of which about 1,000 were the subject of applications for patent rights inside the country.

Meanwhile, Mr Liu said, proposals to set up a China Technology Development Co as a joint venture between China Patent and the State Council's Patent Law Office are still at the discussion stage. The delay in establishing the company, which had been due to open after Lunar New Year, reflects the recent cautious attitude of China towards commercial enterprises opened by government departments, said Mr Liu. "We have to wait until the government has a clearer policy on that."

In addition to promoting Chinese technology in overseas markets, the joint venture would also handle the importation of advanced technology by China.

/12913
CSO: 4010/2015

CONCEPTUAL MODEL PROPOSED FOR TECHNOLOGY DEVELOPMENT

Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 2, 25 Feb 86 pp 6-7

[Article by Guan Yixin [4619 4135 1823]: "A Strategic Model for Technology Development with Chinese Characteristics"]

[Text] We all know that our modernization drive is a profound industrial revolution. What we mean by industrial revolution is a change in the fundamental quality of industrial structures, that is, a great historical leap in the basic composition of industry. But from the point of view of production forces, any industrial revolution is actually a change in the fundamental nature of technology structures, that is, a great historical leap in basic technical composition. Because of this, in the development of technology the basic composition of technical development is technical structures, which then become a fundamental strategic problem to which China's modernization drive must respond and must resolve.

China's National Characteristics

The basic starting point for the consideration of technical structures is the situation regarding production forces and economic and operational modes. Production forces, at the stage China is now in, have from bottom to top manual operations, semi-mechanization, mechanization, semi-automation, and automation, as well as robots in trial production, all at five and six levels of development. On the one hand, economic and operational modes are led by a state-run economy with co-existent varied economic modes; on the other hand, we have pluralistic enterprise operations.

At one time, some comrades "imported" the theory from abroad regarding "rising sun industries -- setting sun industries." Of course, this is not without its use as a "reference system." But most recently even more comrades have clearly pointed out that in China our traditional industries and technologies are still the subjects of industrial development. Unquestionably, this is correct; but this would appear to be over generalized. Because traditional industries, like steel, must surely develop greatly as industries. But their technology should be transformed and optimized. Also, regarding town and township enterprises, some comrades feel that the technology there is backward, that production is scattered, that they cannot form economic results to any scale, and that we ought to use their energy, raw materials, and

transportation in large state-run enterprises. Even more comrades have stressed their position and function in the aspects of their considerable macroscopic scale (output value of town and township enterprises this year is already nearly 30 percent of the gross industrial output value), the fact that they provide employment for large numbers (nearly 50 million) of rural surplus labor, and even at the great significance they have for the industrialization of agriculture and the urbanization of the countryside. From many varying angles, both sides are correct. However, where they fall short is in their lack of a systematic viewpoint, for they have not made comprehensive considerations and overall designs, which is to say that they have not designed a strategic model for overall development.

Actually, the problem is already very clear, and since the challenge to us is under the national situation described above and in the midst of the new world revolution in technology, in arranging our technical structures we should, in the microscopic view, adapt to the diversified production and operations of enterprises and implement a pluralistic technical development; macroscopically, we should adapt to regional, departmental, and urban hierarchical production forces and multiple economic modes, and implement compound technology structures. We can see from this that what ought to be included in technology development strategies that have Chinese characteristics is an overall development model that can assume overall responsibility for everything and can include all important aspects and chief processes, that is, a pluralistic, compound development model.

The Basic Structure of the Model

We can see from the explanation above that what we mean by a pluralistic and compound development model is a particular structural form of technological and economic development strategies conditioned by the current particular Chinese situation. This indicates that it is based upon the state of our production forces at present, which are low level, uneven, and hierarchical; that it is led by a state run economy under a planned commodity economy, multiple economic forms and multiple operational modes exist together as a basis; that has as its basic development mode where production of each micro-unit (enterprise) develops pluralistically and comprehensively, and where macro (sector, region, urban) production forces develop hierarchically and in a compound manner; that has a support system with the fullest compound, collected development of each level of technology has created the strongest "scientific capability for science"; and that has as its goal a thorough realization of modern industrialization that is organically linked with information. This is both the fundamental road for the development of production forces at the current stage in China, and is as well the fundamental policy by which China's drive toward socialist modernization will suit the challenge of the new world technological revolution.

The micro aspects of this model are the diversified technical structures of enterprises and their pluralistic technical development. This macro compound deployment and compound structures (see table) can generally be divided into four compound levels, namely, the rapid advance of low level traditional technology; modernization and transformation of traditional technical specialties; modernization and transformation of traditional technical

information; and development of advanced -- high grade new technology. Among these four levels, from bottom to top, organically unified, the second and third levels, between the modernization of specialties and the modernization of information, are arranged in ascending order with the latter more advanced than the former; there is also a semi arrangement that is not up and down. Therefore, the modernization of specialties refers to the modernization of the particular technology of any industrial sector, such as the advanced metallurgy technology in the steel industry, which is an important factor in the specialty modernization of the steel industry. The modernization of information refers to using rising new technologies like that of microprocessors. Obviously, specialty modernization and information modernization are two inseparable factors as we undertake technical development and technical transformation of an industrial sector or an entire industrial system. There is of course the distinction of earlier and later in development over time.

Table of Basic Compound Structures

Level	Name	Technology Span	Industrial Form	Substance for Technical Development	% of Overall *Structre
1	rapid advance for low level traditnal technlogy	manual operations to mechanization	mostly town & township ent.; some urban collective enter. individ. ent.	implementing the rapid advance from manual operations to traditional (early period) industrialization	not currntly available
2	modern xformaton of tradi-tional technolgy	mechanization to specialized automation	mostly traditional (medium to large entrp.) industry	modernization of specialties, qualified, outfitting with microprocessors, etc.	"
3	modern xformaton of trdtnl technolgy informatn	automation (or mechan) to equip. with new technology	all size enterprises: elctrn precis. mach., instrmnts,chem engineerng,etc	see note 3.4 below	"
4	develop-ment of advanced (hi-grad) technolgy	advanced development of dfrnt degs. need cert. degree dev.	Silicon Valley industrial pk, science cities combined prod. &study enterp.	hi-grade new technology groups & system for corresponding science into technology, technology into production	"

3.4 Implement the transition from traditional industrialization (including the modernization of traditional specialist technologies) to the modernization of information; includes the transformation to flexible production systems from economic modes at scales from differing levels.

A Comprehensive Strategic Construct

Among these structures in pluralistic, compound development, the primary tasking of the first level is to accomplish the industrialization of those portions of our economy that have developed sluggishly and to solve the problem of employment for the large army of laborers who have drifted away from agriculture, as well as problems on the path to Chinese socialist urbanization. In the second level, particular emphasis is laid on carrying out the modernization of traditional industry (specialty modernization). The third level focuses on modern industrialization, that is, transformation by information and arming with information, and also includes in passing the transformation of certain sluggish technologies. In the fourth level advanced technologies are explored and pathfinding industries developed.

In general, the comprehensive strategy for development of China's technology and economy is to consider high-grade, new, advanced, developmental technology groups as potential guiding (or we could say future, in-depth guiding) technical industries; to consider information transformation technology groups as primary guiding (realistic guiding) technical industries; to consider specialized transformation technology groups as principal technical industries; to consider the leap forward of low level traditional technologies as complementary to technical industries, all of which establishes and progressively perfects a technical and economic development strategy that is pluralistic and compound.

Based on this kind of comprehensive concept of a development strategy, this development model has many advantages and characteristics regarding technical development and technical advances, as well as allowing the optimization of industrial structures.

1. The pluralization of micro development. Each distinct enterprise and unit can practice pluralistic development technologically, from the profession in general to individual specialties, from manual operations to technology at every step (even at the highest steps), all can be used in development. As long as the conditions allow, it can be done without a "graded advancement by levels" and without man-made restrictions. In this way we can greatly stimulate and enhance the "nerve endings" and "antennae" of the technical development of each department, and to the greatest degree will make the most of enterprise technology, production potential, and vitality.

2. The compounding of macro deployment. If we say that a country is a fundamental macro unit with deployed production forces, then an urban economic region (such as the Shanghai economic region, the Beijing-Tianjin economic region, etc.) is a lesser macro unit with deployed production forces. Implementing this model for development, be they macro units or lesser macro units, all can deploy their own technical structures and social production forces in multi-level (up to levels of n-dimensions) compounding and networking. Among those levels, there is not only compounding of the four levels, but also some small partial level compounding within each level. Aside from this, we can especially compound the second and third levels, that is the modernization of specialties with the modernization of information.

This will then allow deployment of macro technologies to be optimized for China, which will open a new road by which to improve social production forces greatly.

3. The collectivization of comprehensive structures. The high degree of aggregation and centralization of the structures of technical strategic development must create accumulated, aggregated, and centralized comprehensive compounding of social production forces, in this way generating modern collective economic results. These modern collective economic results are especially generated by the technology intensive, knowledge intensive state of networks created by the compound development of technology. Without compound, pluralistic development structures, we could not speak of modern collectivized economic results.

The Major Economic Significance

Internationally, Schumpeter stressed the central use of creative (breakthrough) technology, while Si-te-la-si-man [phonetic] stressed the peaceful coexistence of old and new technologies. We should scientifically absorb and assimilate the positive components of their strategic thinking regarding the development of technology. However, the most important thing about the pluralistic, compound model of development discussed here is that it is determined by the particular national situation of China. Without any doubt, it is a strategic model for the development of technology that has Chinese characteristics and that can meet the challenge of the new world revolution in technology. Therefore, its progressive establishment and perfection is of great significance and use to the development of our modern socialist economy. First of all, it not only allows production forces at different levels to "get their due" and all be able to develop, but it allows production forces from the lowest to the highest levels to develop in unison, and allows traditional industrialization to combine with information modernization. This is then more suited to the development of a planned market economy. Second, to contain within a compound system the rapid advance of the lowest levels of traditional technology, the modernization and transformation of traditional technical specialties, the modernization and transformation of traditional technical information, and also the exploitation of advanced (high-grade new) technologies, will be even more beneficial to the coordinated development of China's traditional industrialization with modernized information. This has both resolved the problems that the "rising sun -- setting sun" theory cannot, and has also placed the development of town and township enterprises in its proper place. Third, because this pluralistic, compound system has both advanced developmental technology groups for future guidance and also dominant technology groups for realistic guidance, as well as appropriate technology groups to be the main body of technical industries, and complementary primary technology groups, the large compound technology system made up in this way of the four major technology groups is both aware of its compound systematic nature and also clearly distinguishes the relations between dominant and principal parts. This

thoroughly changes the old technology model in which "one point is addressed but nothing else," which was under the kind of thinking that "steel was the key link" or that "grain was the key link." It is certain to generate a high degree of aggregate economic results, and will powerfully promote the transition of China's economy from a "pace model" to a "results model."

This strategic model for technology is of great significance to the development of the economy. How should it be established and perfected? The first thing would be to have urban technical and economic networks as fundamental compound elements, where central cities uniformly organize, coordinate, and control the technology development structures for all urban economic regions. Second, we should strongly develop the commodity economy and make full use of market mechanisms to stimulate and strengthen the necessary standards and capacities of technology for absorption and assimilation by enterprises, as well as a pluralistic development of the awareness of technology. Third, we should do a good job at surveying and deploying industrial structures, linking one industry to another, and shifting the first and second industries toward a third, and we should do a good job at the scientific deployment of technical structures. Fourth, we must have a high degree of strategic vision and do well at the advance and development of high-grade new technologies. Finally, we should actively create the conditions for systems, policies, funding, and talent.

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PROPOSAL TO PROVIDE SPECIAL TREATMENT FOR S&T YOUTH DISCUSSED

Beijing XIANDAIHUA [MODERNIZATION] in Chinese No 2, 25 Feb 86 pp 12-13

[Article by Lan Shuchen [5663 2579 5256]: "An Important Channel By Which To Train Modern Scientific and Technical Talent"]

[Text] "As soon as the sensitive and creative spirit of youth is combined with the bountiful knowledge and experience of mature scientists, they each bring out the best in each other." This is the famous remark of Cambridge University professor of animal pathology, Bei-fo-li-ai, and is a truism demonstrated innumerable times in the history of the development of science. Letting specialists and scholars directly guide "top-notch students" allows them to enter the ranks of world science and technology as early as possible, and is an important channel by which to train modern scientific and technical talent. The reasons lie in the exchange between two strong points and in the fact that they complement each other.

The youth group at the Chinese University of Science and Technology has been a successful experiment. Since this group began in 1978, eight classes of young college students have been recruited. By October 1984, 58 college students ranging from 16 to 20 from the first two classes had achieved masters and doctorate degrees from universities at home and abroad. The experience at this school has been that "this so-called open form of running a school has been to allow students to have contact as early as possible with scholars of true talent and real learning, as well as to receive their instruction." To solidify and develop this achievement, they also "prepare for and invite first rate scholars in the areas of computer science and technology and information science and technology from both at home and abroad to lecture to the students at the university. These scholars pose topics for the students and do their best to let them better understand the topics currently being researched in the front ranks of world science and technology." In addition and based on the suggestion of the internationally renowned overseas Chinese mathematician, Chen Shengshen [7115 4164 6500], in the summer of 1984 we began holding a "summer teaching center for mathematics graduate students." Scholars for this teaching center are primarily selected from first year graduate students admitted or enrolled that year at certain major institutions. It is planned to continue for 5 years, one term each year, with a curriculum of lectures by invited foreign mathematicians of the first rank. This has been recognized as a good way to cultivate youth of outstanding mathematical talent.

Although in this country we have already begun trying out the direct tutoring of "top notch students" by specialists and scholars, in general this cannot be said to be very widespread. For the most part this is just regarded as an arrangement for training talent and developing intellect, and the value of the educational thinking that it reflects has not been deeply explored. Because of this, it is necessary to look more closely at its theoretical and practical significance.

In the history of the educational thinking of mankind, teaching students according to their aptitudes has had an important position, and the way in which it is correct is primarily in that it reflects the differences that exist among people regarding their abilities and moral character. Also, it requires a difference in treatment in accordance with these differences, especially today with the rapid developments in the new technology revolution. Many countries in the world have increased their attention to and emphasis on this problem. The Industrial Development Research Institute of Japan has proposed building a "sophisticated technical college" at the Tsukuba Science City, in which they have obtained the support of the Ministry of International Trade and Industry. In addition to recruiting young technicians from various enterprises, this college will also select certain outstanding high school graduates to be trained, and will employ as teachers research personnel from industrial circles and national research organizations who have rich knowledge of sophisticated technologies. West Germany has also made establishment of a college for top-notch students an important matter for educational reform, and it has allowed private schools to hire the best professors from both at home and abroad and to select the most promising students. What should be especially pointed out is that when these countries have taken these actions they are not only making demands of students, but are also making demands of specialists and scholars. They are especially appreciative of young scientists who are researching in sophisticated disciplines because these scientists can let students know at the earliest opportunity the state of scientific developments. As a great nation with 1 billion people where our youth are one-third of the total population, there are certain to be many intellectuals among them that will develop earlier, and to treat them differently will not only aid in producing more talent and producing better talent, but will also aid in the improvement of the quality of science education for all our people.

Allowing specialists and scholars to tutor directly "top notch students" can allow students to join in scientific research activity earlier and to establish a good foundation. As the amount of knowledge increases constantly, the degree of difficulty for science and technology gets deeper, while the time in which people can study is limited. Because of this, the question of training talent at a younger age is more prominent and urgent than in the past, and this is also a real problem that has been brought on by the rapid development of the new technology revolution. To allow specialists and scholars to tutor directly "top notch" students, to allow students to be in earlier contact with science research, and to firm intellectual and psychological preparations for future engagement in specialties will all help in the solution of this problem. Youth have not only the advantage of age, but can use more of their time in study, their thinking is keen, they are very receptive, and their absorption and assimilation of new things is quick. In

his "Shuo Yuan," Liu Xiang said of scholars during the Western Han dynasty that "to be young and fond of study is like having the sun at sunrise; to be mature and fond of study is like having the sun at high noon; but to be old and fond of study is like using the light of a candle." Obviously, the "light of the rising sun" will last much longer than that of the "light of a candle," or even of "high noon." There are 160 students in the natural sciences night school sponsored by the Russian Atomic Energy Research Institute -- Yi-ku-er-qia-tuo-fu [phonetic] Atomic Energy Research Institute who were selected from older students in ordinary middle schools who had science aptitudes and an interest in research. Their tutors are 20 young scientists studying the newest disciplines. They meet in class twice a week, where they are tutored directly. At the ages of 15 and 16, these students have started on the path of scientific research. This school has been operated for more than 10 years and has graduated hundreds of students, many among whom have become mainstays and key members of the atomic energy research institutes and other science research centers within the country.

By letting specialists and scholars directly tutor "top notch students" we can let students find their direction in time to make the fewest deviations in their paths. "If it is said that I have seen far, that is because I have stood on the shoulders of giants." This sentence by Newton itself includes this reasoning. If we let students understand the newest achievements in science as soon as possible, if they know the direction of development for the research topics they will themselves engage in, and if they understand the focus and difficulties therein, then they will make fewer errors. After a Russian satellite was launched in 1957, the American government immediately proclaimed that training of scientists was the primary mission of the entire country. Then, not only did higher institutions actively prepare materials for middle level schools, but they also sent specialists and scholars to tutor directly "top notch students." As for example where Fairfield College in Connecticut held classes for gifted youth on Saturday mornings, where the curriculum included things from lasers to business management. Currently, these kinds of activities are in the process of developing more deeply.

By letting specialists and scholars directly tutor "top notch students," we can let students better follow up on their school work, the better to develop their creativity. When Qian Sanqiang [6929 0005 1730], China's famous atomic physicist, was young he had the opportunity to hear Wu Youxun [0702 2589 6064] and Sa Benli [5646 2609 2929] lecture on modern physics and electromagnetics, when he fell in love with atomic physics. After he graduated from Qinghua University he went to France to study radium, where he studied under the husband and wife team of Joliet-Curie, and after much struggle and arduous work, he discovered along with He Zehui [0149 3419 1979] the phenomena of "ternary fission" and "quaternary fission," which rocked world physics circles. Of course, we definitely do not deny the development of talent through self study. We have the greatest admiration for those scientific giants who have made outstanding achievements without the direct guidance of specialists and scholars, because the price they have paid is even greater. It was not that they were unwilling to have the guidance of famous teachers, but that these external conditions were not there for them. Had they had them, there is no doubt that their accomplishments and contributions may very well have been even greater. "The correct course is this: absorb everything

that those before you have done, and only then go forward." Although Leo Tolstoy was talking about literary creation, it is similarly applicable to scientific and technical research.

Admittedly, when specialists and scholars directly guide "top notch students," that is an important channel for the training of modern scientific and technical training, and to reach that point we must open up and broaden three channels: college youth groups, the "linking up" of elementary and middle schools with higher institutions and science research organizations, and extra-curricular scientific and technical activities for youth.

First, college youth groups cater to the entire country, students are drawn from a broader scope, and great talent can be gathered together. Teachers, teaching materials, and equipment at the schools are both good and they can be guided by internationally famous scientists. Therefore, on the basis of results already achieved, experiences can be summed up, solidified and improved, the number of students can be appropriately increased, all of which can lead to an atmosphere for the time in which more and better talent is produced.

Second, by "linking" elementary and middle schools with higher institutions and research organizations, they can on the one hand obtain support in areas like instruments and equipment, teachers and training, the offering of courses on modern science and technology, and in the provision of the newest information on international science and technology. On the other hand, times can be arranged to allow high school students to work together with specialists and scholars, giving students the opportunity to understand their ways and methods of working. This consequently broadens outlooks and enriches minds so that they can become new people of a scientific quality.

Third, extra-curricular scientific and technical activities for youth would primarily take part at Children's Palaces and clubs, and is a form in which the majority of children take great delight. For more than 30 years, extra-curricular scientific and technical activities for elementary and middle schools have chiefly featured radio and model airplanes, and the problem now is how to replenish these with new material and open new vistas. Without question, computer math should become an important activity. Central Committee, directors and above of national offices and bureaus, and cadre meet in halls for study, inviting famous specialists and scholars to tell them about the new technology revolution. Youth, and especially "top notch students," should take part in similar sorts of intellectual conferences.

Finally, when it comes to the training of modern scientific and technical talent, if we can work hard together at the three channels of college youth classes, linking elementary and middle schools with higher institutions and scientific research organizations, and extra-curricular scientific and technical activities for youth, then our scientific and technical front will be certain to produce talent in great numbers, and the old will be replaced by the new.

The fundamental goal of the restructuring of our educational system is the improvement of the quality of our people and the greater production and quality of talent. By catering to modernization, to the world, and to the future, and on behalf of China's economic construction and social development in the 1990's and early 21st century, to prepare in large scale qualified talent for all levels and types who can maintain socialist directions is the historical mission that faces us on China's educational front. Letting specialists and scholars directly tutor "top notch students" to hasten the training of modern scientific and technical talent is, in the final analysis, for the realization of this fundamental goal.

12586
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INSTITUTE DIRECTOR RESPONSIBILITY SYSTEM DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, Jan 86 pp 40-43

[Article by Gong Jinxing [7895 6855 2502], Chinese Academy of Sciences, Office of Science and Technology, Beijing Branch: "A Discussion of the Institute Director Responsibility System"]

[Text] I

Currently, China's science research system is progressively pursuing the institute director responsibility system, which is an important reform in micro-management.

Speaking from the view of the theory of management science, implementation of the institute director responsibility system is a natural step. Comrade Deng Xiaoping once pointed out that responsibility must be specialized. Many scholars of management advocate clarifying the responsibilities and authority of the management positions of each level, and these should also be delineated within leadership levels. The central work of science and technology institutes is to advance the work of science and technology. In the aspects of business and administrative management, the institute director should take the whole situation into account and plan accordingly, and should manage his responsibilities exclusively.

Since the 1950's we in China have long practiced a system in which the party committee was in charge of everything, which led to many abuses. The party should manage the party, it should manage principles, policies, and political ideology. Its concern with business and administrative tasks is only a sideline. If central routine duties are all concurrently managed by the party committees, it will be hard to manage well. On the surface everything looks unified, but actually this concurrent management and use of political means as a substitute for business management and administrative management leads to a disjointing of power, authority, and benefits and to the phenomenon whereby a general ideological education supersedes specific business management.

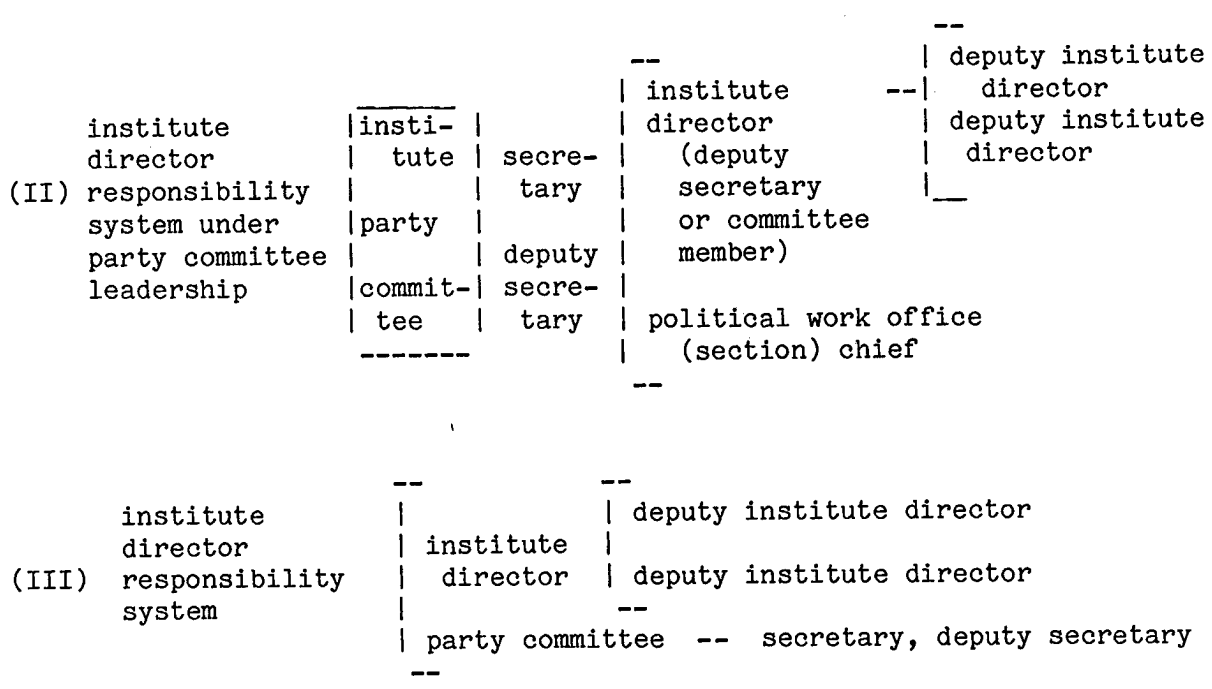
The purpose of implementing the institute director responsibility system is to allow the management of the research institutes to clarify job responsibilities and division of labor, to allow responsibility and authority

to coincide, and consequently to rationalize and strengthen the business and administrative management system of the institute. At the same time, this will enhance the work of the institute party committees.

During this restructuring, the key problem of how to put the institute director into a reasonable position within the management system concerns every area. Because in the new management system the institute director is the central person in decision making and in organization and implementation, and he is the centralized control point for management information. The position of institute director will become the center of the business and administrative management system, and for him to guide effectively we will first of all resolve the problems of the division of labor and cooperation between the party and the administration. Whether or not we can correctly comprehend this point will directly affect the results of the restructuring. If we one sidedly stress things like "the shift of authority between party and administration," taking into consideration the loss of "real authority," of worry about increasing responsibilities, or if we just stress division of labor and consider less cooperation, then we may cause the restructuring to lose its bearings and bring on negative consequences.

Since the 3d Plenary Session of the 11th party Central Committee, responsible departments within the party and administration have been continually thinking of ways to strengthen vocational and administration leadership within the institutes, among which have included expansion of business and administrative autonomy within the institutes, replacing institute directors, progressively clarifying the division of labor between party and administration, etc. After about 5 years time, two major steps have been taken: we first changed to an institute director responsibility system under the leadership of the party committee, and then gradually apply the institute director responsibility system. This restructuring, as concerns changes in structural aspects of the management system, can be shown for the most part in diagram form.

			committee member, concurrently
	institute	director	
		secretary	committee member, concurrently deputy institute director
(I) party committee full responsibility system	party		committee member, concurrently political work office (section) chief
	committee	deputy secretary	committee member, concurrently office head
			. . .



To change in this way, the two lines that are the party and the administration are clearly distinguished, and the abuse by which the party took the place of administration can be basically overcome; but in parallel with this are the accompanying problems of cooperation and coordination. In clarifying the division of labor, party business and political ideology is governed by the party committee and business and administrative work is all managed by the institute director; we want to go on to establish a lateral "interface" between the two lines that are the party and the administration for purposes of cooperation and coordination. Whether there can be coordination between the party and administration is the key to whether the entire institute can be coordinated and whether work efficiency can be improved.

According to the experiences of some units, this "interface" may be designed as follows:

First, establish an "interface" regarding the substance of work. Work within an institute can be divided into three types: one is pure business management and administrative tasks, which clearly ought to be managed by the institute director and deputy director; another kind is building of the party and ideological and political work, etc., which is only logically guided by the party committee; another type is important work that is branched, two sided, and not easily distinguished clearly, as for example the resolution and study of things like directional tasking and planning for the entire institute, important personnel management questions, distribution of gains and major items in job benefits, establishment of structures, and major policy questions, which ought to be studied jointly by the party and administration leadership. Then, according to the nature of the problems, the institute director can handle the situation on his own behalf, while some work could be handled by the party committee.

Second, establish an "interface" in organizations. When the institute director is a party member he ought to participate as much as possible in the party committee, responsible members of the party committee should take part in institute business committee meetings, and key members working in party politics should be a part of relevant business and administration management organizations, as for example work evaluation organizations for technical promotion, so that this work may be done well in concert.

Third, continue the traditional working methods of our party, and set up a "brief meeting" working system between the institute director and the party secretary for timely exchange of information, coordinated deployment of work, and to discuss and resolve important problems in work. Experience has shown that the results from talking and not talking are largely dissimilar.

And looking, too, at the situation from the point of view of vertical relations, in the former party committee complete responsibility system the management chain of command constituted a "mixed up dragon": higher level relevant departments plus the higher level party committee --> the institute party committee --> the secretary and deputy secretary --> the institute director and deputy institute director --> the functioning department of responsibility. After changing to the institute director responsibility system, the two chains of the party and the administration became "two dragons." Administrative aspects: higher level relevant departments --> institute director --> deputy institute director --> the functioning department; aspects of party organization: higher level party committee --> institute party committee --> general branch or branch, where the arrangement is much clearer. A question is what in particular are the "relevant departments" above the institute director. Looking at the "5th Route Army" of the science research system, higher level responsible departments in the research institute above the provincial level are primarily for overall leadership, as for example the research institutes under direct administration by the ministries of the Central Committee and research institutes affiliated with the provincial and municipal science and technology commissions, which for the most part are research organizations subordinate to functioning departments for relations and management; there are 100 research institutes affiliated with the Chinese Academy of Sciences, and it is difficult to govern the institutes directly. Although they are managed by branch academies, the authority of branch academies is limited. Therefore, if there is need for a person of overall leadership over the person of primary responsibility (the institute director), our current system will not accomplish that. The higher authorities in some institutes have not yet implemented administrative senior officer responsibility systems, so the leadership relations with higher levels is even less clear. But in a country like China, where ownership is public, it is of decisive significance whether each type of working position at each level has the support of leadership. The work of institute directors encompasses a multitude of things, there are certain to be errors and deficiencies, some of which will be the responsibility of the director himself and which must have aid, support, and coordination from leadership at the next higher level. The administrative management system of the institute would appear to be similar to the physical and chemical structure of matter: their transformations will consume or absorb energy, so in dissipation systems they must constantly take in energy before they can maintain their stability.

In summary, this vertical "interface" between top and bottom must be firmly established, for isolated requests for institute director responsibility are no way to solve problems.

II

During the past few years, groups from research institutes at all levels have been readjusted and the quality of institute directors has been greatly improved. Taking the CAS as an example, in 1983 the average age of leading groups in the research institutes had dropped to 51, and the great majority of institute directors had vocational training comparable to that of assistant researchers. Subjective conditions in which the institute director responsibility system was implemented has progressively matured. The problem now is that we cannot take only the quality of the institute director himself into account, but more importantly must form business an and administration management structures with the institute directors at the head.

First of all, we must see this as red flowers matching green leaves, for the institute director must have capable and harmonious deputy institute directors to help him. As we understand things at a number of institutes, the qualities of deputy institute directors is quite good, but seldom have they been nominated by the institute directors. The typical way in which things have happened in recent years has been that higher authorities have sent people to help in adjusting leading groups, and after preliminary discussion and consultation with the public, the readjustment is carried out. The results so generated have usually been that individual factors have not been wrong but they have not cooperated, and for awhile it was difficult to form optimal and close structures. In managing the directional tasking, focal points for planning, organizational deployment, etc., for the institutes, these things must be discussed in the midst of actual practice in order to form a unified program; in the areas of working spirit and working methods, there must be a debugging process for working groups at times mutually appropriate. The term of office is generally 3 years, and this "transition period" will take 1 or 2 years. A number of institute directors and deputy directors will experience turmoil in midstream, which will create differences to various degrees. This could happen in one-third and more of the possible situations. But whether or not actions can be taken in concert is just the foremost problem in management, and it may even be said that it is even more important than an individual's degree of accomplishment.

It is our belief that to avoid this kind of "structural defect," future work on the adjustment of institute leading bodies will be divided into two steps: the first will be to fix the proper functions for the institute director and the party secretary, and other functions will be discussed but not fixed. Then, based on nominations by the institute director, we will select deputy directors. In general the adjustments will not be done all at once, and even at the grassroots higher authorities will deploy all working groups.

In order to ensure the formation of optimal structures, when selecting deputy institute directors we would rather be looking for some comrades who have qualifications and a record of service, who have prestige, and whose vocational level is somewhat more modest than that of the institute director

in order to avoid having "many tigers on the same hill" where no one is willing to yield.

We have already experienced too often the misery of non-coordination. But there are still those in the institutes who do not pay this sufficient attention. They are frequently critical that "a new chief brings in new aids" and "cliques and factions form," and even equate the deployment of aides with "bureaucratism." We are opposed to violating cadre principles by appointing people on the basis of favoritism, by arbitrarily seeking connections, but one cannot without analysis oppose action that are similar to "forming a cabinet."

The institute director must have working groups, and aside from some deputy institute directors who are led by the institute director and who ought to be responsible to the institute director, we should also allow for capable and vigorous functionary departments, as for example a Head of Office who can assist the institute director and an Office that can serve as a center for the institute director, as well as working key members who are capable in the areas of business, personnel, and operations. Without a capable and fluid working group, it is like a machine without parts, and the business and administrative management lines that have the institute director as their head would be very difficult to get operating in coordination.

III

As we put the institute director responsibility system into effect, we must still resolve the contradictions within the topic of the institute director itself, foremost among which is the contradiction between being a good institute director and being a good specialist.

Institute directors currently in office are specialists, and in the situation of modern science and technology where it advances by leaps and bounds, if one is away from research work for 3 or 5 years it can cause a specialist to lose certain vocational advantages, and if the time away from research is even longer one may not be able to return to the front ranks of science.

In another sense, institute director is a true responsibility. Under the conditions in which institutes are like "little societies," and especially in the situation where the institute director responsibility system is in effect, the institute director must govern all aspects of work in the research institutes, there is a great deal to do, and if time is not arranged very well, there is seldom opportunity to do research.

As far as job specialties are concerned, the institute director is first of all a research manager and only after that is a specialist of his former profession; to go from being a specialist to being an institute director is a partial vocational transformation. To resolve this contradiction, the vocational accomplishments of the specialist institute director should lean toward the broader and should not be too narrow. Some worry that if this person is not a specialist of the first order then in vocational management he will not be able to keep people in line. This concern is reasonable, but not the whole story. Of our many research institutes, the majority are made up of 3d and 2d order disciplines, some even of 1st order disciplines. Specialists

only specialize in one branch of their discipline, so to use a particular specialist knowledge to guide directly research methods and technical routes in all branches is simply not possible. The older generation of well known scholars are few in number, have high reputations, and many students, and there just are not enough middle-aged specialists with that kind of scholastic and social position. What are truly most useful are the vocational management abilities of newly appointed institute directors; in this situation of catering to the economy and to society, we must have a strong capability for operations and social activity. How the accomplishments are in these two areas is of even more direct significance for institute directors. When a portion of institute directors currently at their positions run into difficulties or have too little initiative, the reason is usually somewhere in these two areas. If this evaluation can be basically accepted, then as we choose and train institute directors and promote the institute director responsibility system, we should reconsider this question. It would be a mistake to use "bookworm" specialists and purely vocational and specialist criteria for choosing. Problems that have already appeared in these areas should be improved with training and stronger help and guidance from actual experience.

There must be a certain authority in management before the institute director can take part in some major or key projects, or before he can take up certain research work. We have made a rough survey of some of the research institutes in an area of the country, and in a few of the more important institutes institute directors spent from 10 to 30 percent of their annual working time in activities outside the institute or in visiting abroad, 30 to 50 percent of their time was spent in administrative meetings both in and out of the institute, 20 to 30 percent was spent taking care of those who had come to visit or to take care of some particular business, and in general no more than 10 percent of the time directly engaged in major projects. In addition, concurrent positions were rather numerous, the fewest being 5 or 6, the most some 20 or more, so social activities took up a correspondingly greater amount of time. These activities benefit the expansion of social contacts; but when social contacts are too numerous, then the benefit is less and the problems more. Relevant departments among the higher authorities have a responsibility to prescribe for and solve these problems.

The institute director, and especially institute directors under the institute director responsibility system, is the legal group entity representative of a unit and the primary portion of this vocational responsibility ought to have legal significance. If we are to allow the institute director to take truly responsibility, we must not only seek ways to improve the person himself, but even more important is that we should resolve and arrange one by one the problems of to whom is the institute director responsible, who governs him, how is work to be shared with the party and cooperated on within the institute, and how are aides best selected and how are working groups best organized, as well as how should supervision by the party committee and the public be managed. In this way, we can avoid pitfalls and more smoothly restructure the micro-management of science research, as well as get the best results from practice of the institute director responsibility system.

12586
CSO: 4008/2076

SICHUAN PROVINCE URGED TO EXPLOIT NATURAL RESOURCES

HK250401 Beijing CHINA DAILY in English 25 Mar 86 p 1

[By Staff Reporter Sun Yougeng]

[Text] Dukou--State Councillor Fang Yi yesterday called for more efforts to utilize natural resources and promote economic take-off in the Sichang area of western Sichuan Province.

He told the participants at a national working conference on the use of natural resources in the area that more should be done to build it into an important industrial raw materials base for the country.

He said the party and government placed great importance on the economic development of the area, which has great industrial and strategic significance.

Since the efforts involved many industries and research institutes, he said, they should begin various forms of economic cooperation on the basis of mutual benefit.

He urged the units to be "more far-sighted." Such cooperation would further break down the barriers between industries and areas, and give "a shot in the arm to economic development," he added.

"It is equally important to speed up its industrial application."

He urged the stepping-up of research into the use and industrial production of titanium magnetite.

On the construction of the second phase of the Panzhihua Iron and Steel Complex, Fang said the project would play an important role in revitalizing the area's economy and in easing the national shortage of steel.

The 3-billion-yuan project, which began last January, is expected to start producing iron in 1989. With scheduled completion in 1992, the project will boost the plant's output of iron and steel by more than 1 million tons each.

On the proposed Ertan hydraulic [as published] power station, Fang said that preparation work should not be slackened. Joint effort was needed to ensure construction starts as soon as possible, he said.

He said a general development plan should be worked out for the second iron and steel base for the Panzhihua-Xichang area, to better exploit the area's abundant mineral and water resources.

Geographical surveys show that the area, which stretches 300 kilometres from Mianning to Yuanmou in Yunnan Province and is more than 100 kilometres wide, boasts 55 minerals, 44 of which are worth industrial mining.

The area has at least 1,500 mineral beds and the potential for more than 90 large and medium-sized mines. The rare metal reserves total 1 billion tons.

The proposed Ertan power station will provide much power for the area's industry.

Personnel training should also not be ignored during development, Fang said. "From now on, we should be ready for the strategic transfer of economic construction to the western part of the country."

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CSO: 4010/2014

TECHNOLOGY EXPORT FAIR OPENS IN SHENZHEN

HK111213 Hong Kong SOUTH CHINA MORNING POST (BUSINESS NEWS Supplement) in English 11 Apr 86 p 5

[From Louis Liu in Shenzhen]

[Text] China's first major technological exposition opened in the Special Economic Zone yesterday, presenting a range of the country's top export items.

More than 200 firms are taking part in the 10-day China Shenzhen Technology fair, offering the public a rare look at the most advanced Chinese products in fields such as nuclear energy, electronics, aviation, astronautics and defence.

The most spectacular items on show are a replica rocket and satellite and television antenna dishes outside the exhibition hall. But some foreign visitors consider many exhibits far from advanced by international standards and were surprised to see iron grilles, herbal medicines, and even garments on display.

The organizers said most of the products were the results of applied technology.

The telecommunications satellites and Long March II and III rocket launchers are the pride of China's aerospace industry, which hopes to become a serious competitor to the European Ariane Space Consortium and the US space agency NASA.

Visitors are also offered a look at civilian applications of China's nuclear technology, in particular a micro-reactor for scientific and medical use, offered for a highly competitive US$750,000.

The micro-reactor, for instance, might be sold along with nuclear fuel to Pakistan, Hong Kong, Sri Lanka, Zambia and Burma, said Li Zhongping, an engineer at the Atomic Energy Institute.

To show the importance it places on the exposition, Beijing has sent to Shenzhen an array of ministers, vice-ministers and other top government officials, including Ding Heggao, Minister of the Commission of Science, Technology and Industry for National Defence.

About 150 representatives of foreign companies are said to be attending.

Beijing aims to sell its wares to industrialized, as well as developing countries. "We intend to sell our launchers and satellites around the world at prices 15 percent lower than the competition," said Xu Dexin, an engineer at the Academy of Space Technology, adding that negotiations were already underway with five or six countries.

High technology export contracts will enjoy strong legal protection and preferential treatment, Xie Guang, vice-director of the Commission of Science, Technology and Industry for National Defence, said at the fair's opening. He said the state's move to convert its military industry and research into commercial production tied in well with the country's open-door policy.

Many of the products displayed were regarded as confidential until recently.

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CSO: 4010/2015

IMPACT OF SEA-AIR HEAT EXCHANGE OVER NORTHWEST PACIFIC STUDIED

Beijing HAIYANG KEXUE [MARINE SCIENCES] in Chinese Vol 9 No 1, 9 Jan 85 pp 11-15

[Article by Jing Licai [0064 4539 2088]: "The Effects of Sea-Air Heat Exchange Over Northwest Pacific on China's Flood Season Precipitation," Oceanography Institute, Chinese Academy of Sciences]

[Text] The heat exchange at the interface of ocean and atmosphere is an important aspect of the sea-air interaction. The amount of heat transferred from ocean to atmosphere has significant impact not only on the thermal status of the ocean surface but also on the formation and change of weather and climate patterns. It is obvious from available information that changes in the thermal status of northwest Pacific Ocean have significant impact on precipitation in the Chinese mainland. In this article, attempts are made to correlate the flood season precipitation in the mainland with the sea-air heat exchange values compiled for a large area of northwest Pacific over an extended period of time.

I. Data Processing and Calculation Procedures

A total of 351 mesh points covering northwest Pacific between 0°N-54°N and 105°E-170°W were chosen. The sea-air heat exchange values of the months between January 1961 and December 1974 were calculated for each mesh point. The equations used are as follows:

$$Q_E = 0.143\times10^{-1}(597.0.6T_W)\ (e_W-T_a)V \quad (Cal/cm\cdot day)$$
$$Q_C = 0.95\times10^{-2}\ (597-0.6T_W)\ (T_W-T_a)V \quad (Cal/cm\cdot day)$$

where Q_E and Q_C are latent heat and sensible heat respectively. T_W is water temperature and T_a air temperature; V is wind speed; e_W is the saturated vapor pressure calculated from surface water temperature (mPa); and e_a vapor pressure of air (mPa).

In studying the impact of the sea-air heat exchange over northwest Pacific on the precipitation in China, we chose, based on the divisions of China's flood season rain zone, the South China region (Guangzhou, Shantou, and Shaoguan, May-July), Nanling region (Guilin, Ganzhou, and Zhijiang, April-June), Jiangsu-Zhejiang region (Shanghai, Hangzhou, and Wenzhou, May-July), Changjiang (Wuhan, Jiujiang, Wuhu, Nanchang, Anqing, and Tunxi, June-August),

North China region (Beijing, Baoding, and Shijiazhuang, June-August), Northeast region (Harbin, Changchun, Shenyang, and Yanji), and Qingdao (June-August) as testing regions. The monthly precipitation data (the average of several locations) of these eight testing regions during flood season were used to study their correlations with the latent and sensible heat data of the same period or earlier period (up to 19 months) at each point over northwest Pacific. The correlation coefficient is defined by the equation:

$$R = \frac{\Sigma((X-\bar{X})(Y-\bar{Y}))}{\sqrt{\Sigma(X-\bar{X})^2\Sigma(Y-\bar{Y})^2}}$$

where X denotes heat exchange value and Y precipitation.

II. The Basic Conditions of Sea-air Latent Heat and Sensible Heat Exchange

In order to understand the basic situation of the sea-air latent and sensible heat exchange in these waters, we calculated the averages and weighted averages of several year's data. It can be seen from Figure 1 that the greatest latent heat exchanges of the area occur along the North Equatorial Current, the Kuroshio and the Westwind Drifting Zone. The average latent heat transfer for the North Equatorial Current region is 400 cal/cm^2•day, the maximum for the East China Sea section of the Kuroshio is 555 cal/cm^2•day, and for the Japanese Kuroshio 583 cal/cm^2•day. Furthermore, there is a high exchange area in the South China Sea region with a maximum of 448 cal/cm^2•day. Water temperatures are higher in these regions and evaporations greater. Hence they are the waters with most active sea-air heat exchange. In the medium- or high-latitude areas, there emerge the low exchange areas due to the influence of the cold waters from the Oyashio. In the mixing region of the Kuroshio and Oyashio, the latent heat isotherms are more densely packed. The distribution of the multiple-year averages of sensible heat roughly agrees with the trend in the distribution of latent heat. There also exists a belt of high exchange values in the core region of the Kuroshio with the maximum of 135 cal/cm^2•day. The values are positive throughout the area but their differences are not as remarkable as that of the latent heat exchange values.

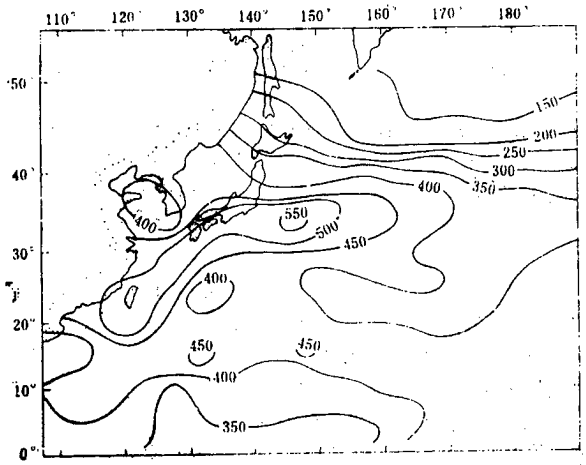

Figure 1. The Distribution of the Multiple-year Averages of Latent Heat

In general, our calculation results agree with those of Wyrtki's[1] (the maximum for latent heat >300 cal/cm^2•day and for sensible heat >80 cal/cm^2•day) and with those of the Atmospheric Physics Institute of the Chinese Academy of Sciences[2] (the maximum for latent heat about 550 cal/cm^2•day and for sensible heat >80 cal/cm^2•day).

In order to understand the characteristics of the seasonal and yearly changes in the sea-air heat exchange, we calculated the monthly progressive means of latent and sensible heat over a number of years. To be as brief as possible, only the Kuroshio will be discussed as a representative case. It can be seen from Figure 2 that, for both latent and sensible heat, the largest values appear in winter and the smallest in summer. The maximum appeared in January with an average of 785 cal/cm^2•day and the minimum in June with an average of 217 cal/cm^2•day. The sea-air latent heat exchange is negative in summer (heat transfers from air to sea) but positive (heat transfers from sea to air) in all other seasons. The maximum heat loss of the ocean in January is 256 cal/cm^2•day and the maximum heat gain in July is -12.7 cal/cm^2•day. To understand the yearly variations in heat exchange, we similarly calculated the yearly variations of the weighted averages of latent and sensible heat in winter (February) and summer (August) from the average values of 20 points inside the Kuroshio region. It can be seen from Figure 3 that the yearly variations of latent and sensible heat in winter within the core region of the Kuroshio are similar, i.e. with substantial yearly variations, the highest weighted average of latent heat being 165 cal/cm^2•day. The yearly variations of latent and sensible heat in summer are smaller than those in winter, the highest weighted average of latent heat being 80 cal/cm^2• day. The yearly variations of sensible heat are rather small.

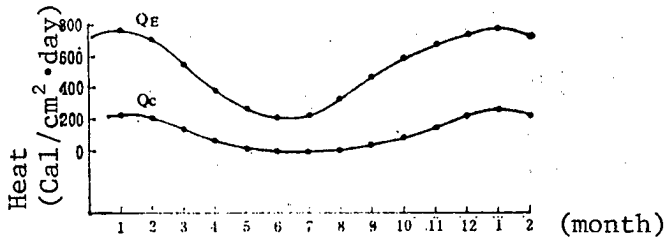

Figure 2. The Yearly Variation Curves of the Latent and Sensible Heat of the Kuroshio Region

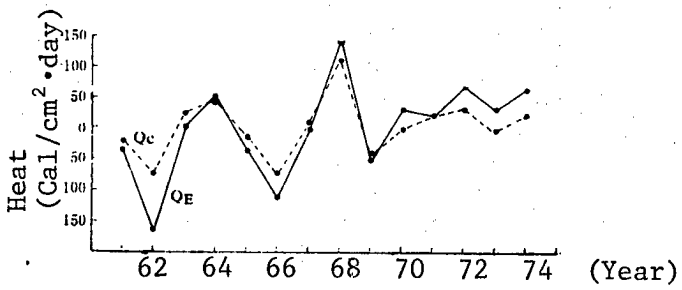

Figure 3. The Weighted Average and Yearly Variation Curves of the Latent and Sensible Heat of the Kuroshio Region in February

III. The Relationship Between the Sea-air Heat Exchange and China's Flood Season Precipitation

1. Key Areas and Months That Show Significant Impact on China's Flood Season Precipitation

In our survey, we discovered large correlation areas having correlation coefficients greater than 0.5. These areas are mainly located within the Kuroshio, Westwind Drifting Zone and South China Sea region, and western section of the North Equatorial Current. In this article, we picked those areas in the correlation field of the latent heat of the key areas with respect to China's flood season precipitation that contain more than 10 points with a confidence of greater than 0.01 and carried out statistical study (see attached table). The statistical results show that there are strong positive correlations of the latent heat values of the key areas with the flood season precipitation of the South China, Nanling, Jiangsu-Zhejiang, and Changjiang Delta region and strong negative correlations with that of the middle and lower reaches of the Changjiang, North China, and Northeast region as well as Qingdao. The key months in the correlation field usually start to emerge the previous summer, reach the optimum in winter and last until early spring, the longest stretch lasting for 13 months (e.g. the North China region). The analysis reveals that the preseason latent heat, a factor that affects the precipitation of all regions, gives large areas of high correlation with high degree of confidence. Two areas cover 38 and 44 of such points with a confidence of 0.01 and 0.001, respectively. When the progressive means of the weighted averages at these correlation points that cover a large area are calculated and their correlations with flood season precipitation examined, the confidence of all of them meet the requirement and some are even improved. This shows that the sea-air heat exchange over northwest Pacific has certain impact on China's flood season precipitation and opens up the possibility of using the sea-air heat exchange values to forecast the precipitation that takes place later.

2. The Continuous Changing Pattern of the Correlation Fields

(1) Changes in the correlation field of the preseason latent heat with the flood season precipitation of the North China region. First, we studied the continuous changes in the correlation fields of the key areas. The analysis of the North China region and the preseason latent heat shows that there exists a large area of high correlation between the two. To explain the distributions and changes of the correlation field between the two, changes of the high correlation areas since last June are given in Figure 4. Judged by the correlation field, the correlation coefficients were small prior to last June but by June there appeared a cluster of 20 points in the western section of the North Equatorial Current that have negative correlation coefficients greater than 0.5, the largest being -0.80, and confidence exceeding 0.001. The number decreased in July and reached 10 in August, the largest correlation coefficient being -0.74. At the same time, there also appeared 10 high correlation points in the core region of the Kuroshio, the largest being -0.72 and correlations as high as 0.74 also appeared in the Westwind

Statistical Table of Sea-air Heat Exchange (Latent Heat) Over the Northwest Pacific Ocean and China's Flood Season Precipitation

Region	Month with highest precipitation during flood season	High correlation region	Key months of high correlation	Number of points within the high correlation region	Largest correlation coefficient	Confidence of correlation
North China Region	May	Kuroshio Region	Last February	14	0.77	0.01
	"	" "	Last March	16	0.69	0.01
	"	" "	Last December	16	0.81	0.001
	"	" "	This March	14	0.83	0.001
	June	Westwind Drifting Zone	Last November	19	0.85	0.001
Nanling Region	April	Kuroshio Region	Last July	11	0.80	0.001
	May	" "	Last July	15	0.72	0.01
	"	" "	Last November	21	0.74	0.01
	"	" "	Last December	20	0.75	0.01
	"	" "	This April	16	0.80	0.001
	June	" "	This March	12	-0.63	-0.02
Jiang-Zhe Region	May	Kuroshio Region	This April	13	0.76	0.01
	July	West Flank of the North Equatorial Current	Last July	11	0.69	0.01
Changjiang Delta	May	Kuroshio Region	Last December	16	-0.75	0.01
	"	Westwind Drifting Zone	This February	12	0.75	0.01
	June	West Flank of the North Equatorial Current	Last March	15	0.75	0.01
	June	South China Sea Region	This March	12	0.78	0.001
Middle and Lower Reaches of Changjiang	June	Kuroshio Region	This February	11	-0.64	0.02
	July	" "	This May	17	0.75	0.01
	August	" "	This January	19	-0.75	0.01
	August	" "	This June	12	-0.92	0.001
	August	" "	This August	10	-0.77	0.01
North China Region	July	Kuroshio Region	Last May	11	0.74	0.01
	July	" "	This April	10	-0.70	0.01
	August	Westwind Drifting Zone	Last June	13	-0.80	0.001
	August	" "	Last August	10	-0.74	0.01
	August	Kuroshio Region	Last October	17	-0.71	0.01
	August	" "	Last December	22	-0.83	0.001
	August	" "	This April	21	-0.82	0.001
	August	West Flank of the North Equatorial Current	This July	22	-0.81	0.001
Northeast Region	June	Kuroshio Region	Last January	12	0.69	0.01
	June	" "	Last March	44	0.72	0.01
	July	West Flank of the North Equatorial Current	Last September	11	-0.80	0.001
	July	Kuroshio Region	This February	14	-0.71	0.01
	August	" "	Last November	11	-0.60	0.02
	August	" "	This January	17	-0.82	0.001
Qingdao	July	Kuroshio Region	Last July	22	-0.72	0.01
	"	" "	Last September	30	-0.81	0.001
	"	" "	This April	10	-0.67	0.01
	"	" "	This July	38	-0.79	0.001

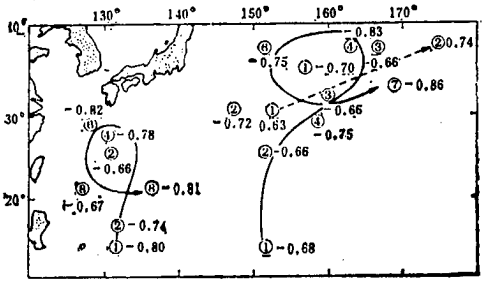

Figure 4. Changes in the High Correlation Areas Between the Latent Heat Values and the August Precipitation of the North China Region

①②③④ represent the correlation areas of last June, August, October, and December, respectively

⑥⑦⑧ represent the correlation areas of this April, June, and July, respectively

Drifting Zone. The high correlation points in the Kuroshio region decreased in September while the number increased to 10 in the Westwind Drifting Zone, the largest value being -0.78. In October, 22 high correlation points resurfaced in the eastern core region of the Kuroshio, the largest being -0.66. The number decreased in November. In December, 22 high correlation points appeared in the Kuroshio region and the southern part of the Oyashio, the largest being -0.83. The number decreased in January, February, and March. In April, there appeared an area with 21 high correlation points in the core region of the Kuroshio, the largest being -0.82. When one takes the progressive means of the weighted averages of the latent heat values of these 21 points and examined their correlations with the precipitation, the correlation coefficients reach as high as -0.81 and their confidence exceeding 0.001. In June, there appeared seven high correlation points in the Kuroshio region and the Westwind Drifting Zone, the largest being 0.86. The weighted averages of the latent heat values were treated similarly and their correlations with the August precipitation of the region examined. The correlation reaches 0.93, which far exceeds the confidence of 0.001. In July, there resurfaced 22 high correlation points in the North Equatorial Current region, the largest being -0.81. Treated similarly and a correlation coefficient of -0.72 was obtained. From the above analysis, several features of the changes in the correlation fields emerged:
a) Since last June, large patches of high correlation appeared every other month, and there exists large, high-confidence correlation areas between the latent heat and precipitation for June, August, October, December of last year and February, April, June, and July of this year. b) Except for small areas with positive correlation in last June and August, the correlation fields of all other months have negative correlations. In other words, there are less August precipitation in the North China region when there is a higher than normal transfer of heat from sea to air within this part of the ocean and more precipitation when the opposite is true. c) The key areas that affect the August precipitation of the North China region are concentrated in the outer flank of the East China Sea section of the

Kuroshio, the lower reaches of the Kuroshio and the southern tip of the Oyashio. As shown in Figure 4, the solid lines illustrate the changes in negative correlations and the dotted lines positive correlations. Judged by the changes in the solid line correlation areas, it seems that there exist two synchronized, incomplete-pretzel-shaped routes from south to north. Both are originated at the North Equatorial Current (near 15°N and 150°E) and travel north at the same time until they reach the outer flank of the East China Sea section of the Kuroshio and the lower reaches of the Kuroshio, respectively, where they start to circle counterclockwise.

2. The changes in the May precipitation in the Nanling region. It can be seen from Figure 5 that the correlation coefficients were small prior to last June. In June, there appeared nine high correlation points in the North Equatorial Current and near the South China Sea region (15°N). In July, they shifted north and expanded to cover the Kuroshio region and their number was increased to 15, the largest correlation coefficient being 0.72. In August, seven high correlation points appeared near southern Taiwan, the largest being 0.75. In the meantime, 10 and 7 high correlation points emerged in the North Equatorial Current region and the core region of the Kuroshio, respectively. In September, the high correlation areas moved to the east side of the Kuroshio. In October, they moved back to the Westwind Drifting Zone. The high correlation areas were expanded to cover 15 points with the largest correlation coefficient reaching 0.80. In November, they moved again to the core region of the Kuroshio and there emerged two high correlation patches, each containing 11 points with the largest coefficient being 0.74 and 0.75, respectively. There were also six high correlation points in the upper right corner of the core region of the Kuroshio. In December, there appeared over 20 points in the east flank of the core region of the Kuroshio and the largest coefficient is 0.79. There is no significant high correlation areas in the correlation fields of the May precipitation of the Nanling region with each month of last year and therefore there are less impacts. It can be concluded from the analysis in Figure 5 that: a) Except for small areas of negative correlation last August and September, all the remaining months have positive correlations. This is exactly the opposite situation of the August precipitation in the North China region. Therefore, it has opposite effect on the precipitation. b) The key areas clearly scattered near the North Equatorial Current and the entire Kuroshio and Oyashio region. The correlation fields of last May-November all have impacts on the May precipitation of the Nanling region. For the East China Sea section of the Kuroshio, last September-November has more impacts and for the Japanese Kuroshio and Oyashio, May-August shows obvious impacts. The changes in the high correlation areas started at the North Equatorial Current region and gradually moved as months passing by to the core region of the Kuroshio where they wandered about.

In summary, China's flood season precipitation has better correlations with the sea-air heat exchange values of the areas within the Kuroshio, North Equatorial Current, Westwind Drifting Zone, and the South China Sea region with the Kuroshio having the most significant impact. Judged by their impact on the North China and Nanling regions, the key areas took shape in the North Equatorial Current region the previous year and gradually moved

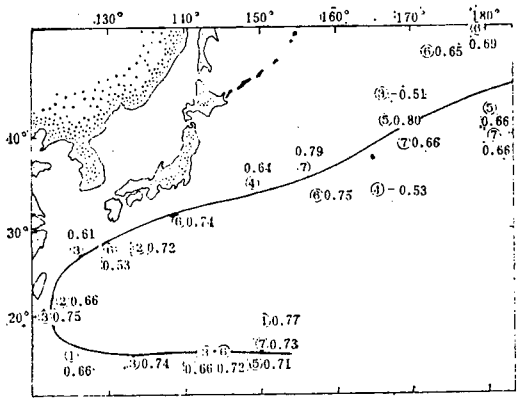

Figure 5. Changes in the High Correlation Areas Between the Latent Heat Values and the May Precipitation of the Nanling Region

①②③④⑤⑥⑦ represent the correlation areas of last June, July, August, September, October, November, and December, respectively

toward the Kuroshio region. Largest number of high correlation points with largest correlation coefficients appeared in winter. It is noteworthy that the correlation field of the latent heat with the precipitation in the North China region shows negative correlation distribution while with the Nanling region it shows positive correlation distribution. We believe that the emergence of the high correlation areas and the changing pattern of the correlation fields are the results of certain internal connections among the interactions of ocean and atmosphere. The physical mechanism of these interactions awaits further investigation.

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FUZZY CLUSTER ANALYSIS OF NORTH PACIFIC SST, ITS CONNECTIONS WITH SUBTROPIC PACIFIC HIGH

Beijing HAIYANG KEXUE [MARINE SCIENCES] in Chinese Vol 9 No 4, 9 Jul 85 pp 15-18

[Article by Yu Yanling [0060 1750 3781]

[Text] The classification of sea surface temperature (SST) is traditionally performed by visual methods. In this article the method of fuzzy cluster analysis is used to study the distribution of winter SST anomalies in the north Pacific for the period 1949-1975. They are shown to be correlated with the subtropic Pacific high (SPH).

I. Basic Principle and Method of Analysis

Fuzzy cluster analysis is a mathematical method of classification of events or objects which have fuzzy relations. It involves the application of conventional equivalence relations to fuzzy equivalence relations, and the extension of subordinate relations of ordinary sets in $\{0,1\}$ to a continuous region of $[0,1]$. When the level of intersection λ varies from 1 to 0 in this region, the classification becomes increasingly coarser, and forms cluster dynamic patterns which are constructed from ordinary classification analysis. This procedure will produce better classification results by judiciously selecting the level λ.

The basic analysis approach is as follows: First, natural orthogonal decomposition is performed on the sea temperature of the north Pacific during each of the winter months (December, January and February) from 1949 to 1975 to produce the first three time coefficients; then successive averages of the coefficients are taken:

$$T_{ij} = \frac{1}{3}\left(T^{12}_{ij} + T^{1}_{ij} + T^{2}_{ij}\right) \qquad \begin{pmatrix} i = 1, 2, \cdots\cdots 26 \\ j = 1, 2, 3 \end{pmatrix}$$

where T_{ij}^{12} is the jth time coefficient of the December data of the ith year; T_{ij}^{1}, T_{ij}^{2} are respectively the jth time coefficients of January and February of the following year. This produces a new sequence of winter average time coefficients consisting of 3 elements and 26 years of data; this sequence is then used in the cluster analysis.

After normalization, one can compute the correlation coefficients between different elements of the new sequence to reflect the degree of similarity of the various characteristics from one year to another. Since the correlation coefficients range between [-1,1], they must be first transformed to the range (0,1) in order to satisfy the requirement of cluster analysis.

To perform cluster analysis, the correlation matrix R must also satisfy the equivalence relations, i.e.,

1. symmetry: $R(x,y) = R(y,x)$
2. auto-inversion property $R(x,x) = R(y,y)$
3. transitivity $R \supseteq R \circ R$

In general, a fuzzy relation only satisfies the first two conditions; therefore, it must undergo an equivalence transformation, i.e.,

$$ROR = R^2, \quad R^2 \circ R^2 = R^4, \quad \ldots \ldots$$

where $\circ$ is called the faltung operation

$$ROR = \bigvee (rik \wedge rkj)$$
$$(i,j,k = 1,2, \ldots \ldots 26)$$

If at a certain step,

$$R^p = R^{2p}, \quad p = 1,2,4,8, \ldots \ldots$$

then the transformation is complete, and cluster analysis can begin. By applying different levels of intersection λ to the results of cluster analysis, a fuzzy cluster dynamic pattern can be generated (Figure 1).

Direct comparisons show that best results are obtained if $\lambda = 0.90311$ and the 26 winter north Pacific SST's are divided into 3 different modes. (Table 1)

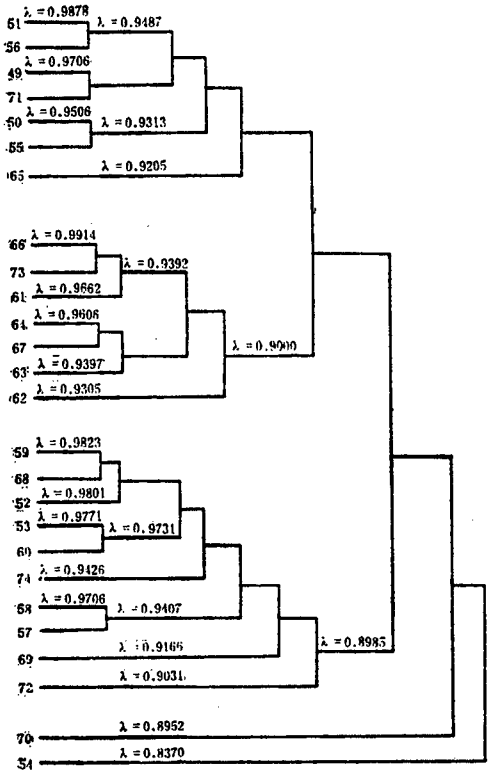

Fig. 1 Cluster Dynamics

II. Discussion

1. Classification Results

Both Table 1 and Figure 2 indicate that there are distinct differences between the modes.

The average sea temperature distribution diagrams presented here are based on approximations using the first three components of the orthogonal decomposition procedure because they are regularly distributed about the positive and negative centers, and they are also very close to the actual distributions (approximately 80 percent of the actual field). The "+" and "-" in the diagram represent the positive and negative centers of temperature variations. It shows that the centers of warm and cold anomalies of the winter SST are mostly located in the main ocean current regions of the northern Pacific.

Table 1. Classification of Different Modes of Water Temperatures

Mode	Time coefficient \ Year	1949	1950	1951	1955	1956	1965	1971				Average
I	T_1	0.69	1.35	1.27	0.53	1.24	1.98	0.85				1.14
	T_2	-2.71	-4.79	0.04	-3.55	-0.52	3.16	-3.26				-1.66
	T_3	3.63	0.44	2.04	-1.04	3.33	3.58	2.15				2.02
Mode	Time coefficient \ Year	1952	1953	1957	1958	1959	1960	1968	1969	1972	1974	Average
II	T_1	-4.41	-2.66	-3.60	-5.87	-2.52	-5.86	-1.27	-2.34	-1.10	-0.38	-3.00
	T_2	0.95	-1.52	5.33	4.40	0.37	-0.74	0.17	1.99	3.90	-0.65	1.42
	T_3	-0.92	-1.50	1.07	2.62	0.12	-3.77	-0.42	-2.84	3.48	-1.06	-0.32
Mode	Time coefficient \ Year	1961	1962	1963	1964	1966	1967	1973				Average
III	T_1	1.88	5.69	0.47	2.70	0.67	6.39	1.91				2.82
	T_2	-0.52	13.22	0.12	0.16	-1.43	2.71	-3.16				1.59
	T_3	3.62	-7.44	-0.46	-0.53	-1.75	-3.37	-5.59				-3.25

2. Correlation Between the Classification Results and the Subtropical Pacific High

The intensity of the subtropical high is expressed in terms of the 500 mb west Pacific high area indices collected during the period 1954-1975 and published by the Central Weather Bureau. In order to eliminate short-term and yearly fluctuations of the SPH, we use the distance between the monthly average and the mean value as the intensity measure, denoted by Δ M.

Table 2 shows that for modes I and III, all area indices have negative Δ M's except for year 1966 (mode I) and year 1962 (mode III); on the other hand, for mode II, all Δ M's are positive except for year 1975. This illustrates that when the distribution of the winter average temperature field is in the form of mode I or mode III, the SPH for May of the following year will be relatively weak; when the distribution is in the form of mode II, the SPH will be strong.

3. Preliminary Analysis

The winter SST distribution of the north Pacific provides a good indication as to how the SPH will vary the following year. Analyses show that the first time coefficients from natural orthogonal decomposition of modes I and III winter sea temperature data are all positive, whereas the mode II coefficients are all negative. The magnitude and sign of these time coefficients determine the amplitude variation of the eigen vector field with time. Therefore, the first component field, which is the product of the first time coefficient and the eigen vector, provides an accurate measure of the basic sea temperature variation of that particular year.

It can be seen from Figure 3 that modes I and III distributions will have a warming effect in the north and a cooling effect in the south, the positive and negative Δ M centers are located in the north-central part and the southwest part of the northern Pacific respectively; the mode II distribution of the first component field has just the opposite effect, i.e., cooler in the north and warmer in the south, and the positive and negative Δ M centers are located in the southwest and north-central parts of the northern Pacific.

Table 1 also shows that the main periods of rising temperatures in the equatorial east Pacific region are all of mode II, whereas the typical cold water years in the equatorial east Pacific are of mode I or mode III. This illustrates that the anomalies of rising and falling water temperatures in the equatorial east Pacific region are correlated with the north-south SST gradients of the entire Northern Pacific. These global temperature variations which take place almost simultaneously in both north-south and east-west directions will inevitably affect the intensities of the Hartley circulation caused by the north-south temperature gradient and the York circulation caused by the east-west temperature gradient.

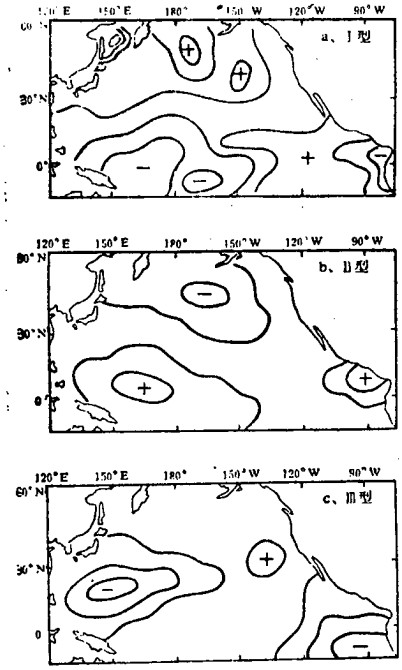

Fig. 2 Average ΔM Distribution of the Sea Surface Temperatures for Three Different Modes

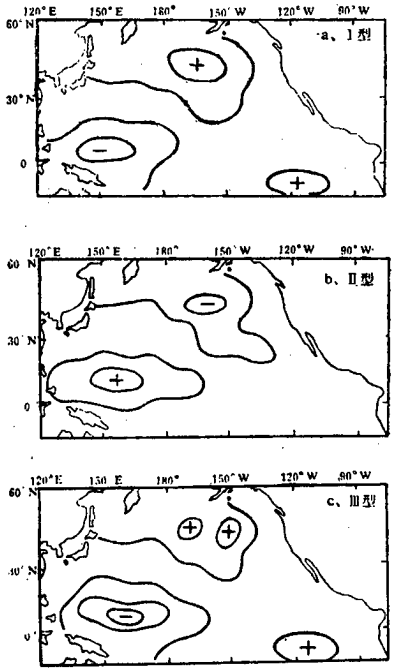

Fig. 3 First Main Component Field of Sea Temperature ΔM for the Three Different Modes

Table 2. Values of Subtropical High's Corresponding to the Classification Results

I Mode	Year	1956	1957	1966	1972					
	ΔM	-1.9	-9.9	2.1	-3.9					
II Mode	Year	1954	1958	1959	1960	1961	1969	1970	1973	1975
	ΔM	2.1	9.1	4.1	9.1	5.1	14.1	7.1	7.1	-6.9
III Mode	Year	1962	1963	1964	1965	1967	1968	1974		
	ΔM	9.1	-4.9	-6.9	-0.9	-8.9	-10.9	-9.9		

The reason that modes I and III sea temperatures are correlated with the SPH and opposite to mode II sea temperatures is because the winter SST field determined by the first component of modes I and III is primarily positive in the north and negative in the south, whereas the mode II SST field is just the opposite.

Figure 4 shows that the frequency of occurrence of the mode II SST and the mode I, mode III SST's are very similar to the frequency of occurrence of the positive and negative Δ M's of the SPH area indices. If the appearance of mode II sea temperature field shows increase in the north-south temperature gradient in the northern Pacific, and the appearance of mode I or mode III sea temperature field shows decrease in the temperature gradient, then there is an approximately 3-5 month lag behind the cycle of variation of the north-south temperature gradient and the cycle of variation of the SPH intensities during the month of May of the following year.

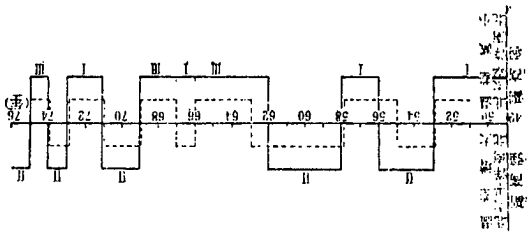

Fig. 4 Correlation of Frequency of Occurrence Between Sea Temperature Data of Different Modes and the Subtropical Highs

A large subtropical circulation system exists in the upper atmosphere over most of the northern Pacific regions; variations in the intensity of this system will inevitably affect the oceanic laminar system below and therefore change the global distribution of SST's. On this basis we postulated a possible correlation model between variations in the north-south SST gradient and variations in the SPH intensity. When the north-south temperature gradient of the winter SST of the northern Pacific increases, the subtropical high intensifies, and the east-west wind also increases. As a result, the transport of cold water from east to west at low latitudes and the transport of warm water from west to east at mid latitudes both intensify; this process may last from 2 to 7 years. The exchange of cold and warm water between north and south gradually forms the characteristic distribution of a positive field in the north and a negative field in the south, which leads to lower water temperature in the west part of northern Pacific and higher water temperature in the north-central part. At this point the north-south gradient of the SST is reduced, with corresponding weakening of the SPH; as a result, the east-west wind decreases, and the north-south gradient of the SST begins to increase. This model explains how the SPH varies cyclically with the north-south SST gradient in the northern Pacific.

The above discussion shows that it is feasible to apply fuzzy cluster analysis for classifying SST, particularly in conjunction with the method of natural orthogonal decomposition; this method is more objective and provides better insight than the method of direct classification. However, there are still cases where the classification results do not agree with observations; hence further improvements of the method should be made to increase its classification accuracy.

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IMAGE INFORMATION MEASURE DESCRIBED

Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 13 No 5, Sep 85 pp 116-118

[Article by Xie Weixin [6200 4850 0207] of Northwest Telecommunications Engineering Institute: "A Measure for Image Information"; this problem was supported by the Chinese Academy of Sciences. Recieved March 1984, revised October 1984]

[Text] Abstract: Based on the theory of information measure for fuzzy sets, the information measure for gray-tone images is discussed. The theoretical results show good agreement with previously published experimental results. From the viewpoint of image information, during image processing the images with gray levels between 3 bits and 4 bits have good quality.

Various aspects of image processing and human perception of the image are intimately interrelated. Especially when the image is presented for viewing, in designing image digitalization, or from strengthening one must understand the subjective qualities of the image and its fidelity with regard to the original scene. Because the end recipient of the image is the human vision system, this process involves questions of perception. Research concerning the question can be related to fuzzy mathematics. With a single image conceived as a fuzzy set as a basis we derive calculation formulae for information measure of an image possessing a flat historgram. Theoretical results are in close agreement with previous experimental results.

Fuzzy Entropy of the Image and Image Information Measure

By the concept of a fuzzy set an M by N element image with L gradations can be seen as a fuzzy set.[1,2] Each element in the set possesses a subordinate function with respect to the maximum brightness. We call this fuzzy set the image equivalent set I, represented as

$$I = \sum_{m=1}^{M} \sum_{n=1}^{N} \mu(l_{mn})/i_{mn} \qquad (1)$$

In this formula, $\mu(\ell_{mn})\ (0 \leqslant \mu(\ell_{mn}) \leqslant 1)$, represents the subordinate function of the graduation level μ_{mn} of image element i_{mn} with respect to the maximum brightness. $\mu(\ell_{mn})$ can be gotten similarly to the standard function S in reference [3].

The entropy of the image equivalent fuzzy set I we call $H_f(\mu)$. Based on the definition of the entropy of a fuzzy set[4] we get

$$H_f(\mu) = \frac{1}{MN} \sum_{m=1}^{M} \sum_{n=1}^{N} S(\mu(l_{mn})) \tag{2}$$

in which $$S(\mu(l_{mn})) = -\mu(l_{mn}) \log_2 \mu(l_{mn}) - (1-\mu(l_{mn})) \log_2 (1-\mu(l_{mn})) \tag{3}$$

is the Shannon function. Setting the image histogram as $h_g(\ell)$, then we get

$$H_f(\mu) = \frac{1}{MN} \sum_{l=0}^{L-1} h_g(l) S(\mu(l)) \tag{4}$$

From the calculation formula for the general information measure of a fuzzy set[5] we can derive the image information measure H_{tot} to be

$$H_{tot} = H_s(p_1, p_0) + H_f(\mu) = -p_1 \log_2 p_1 - p_0 \log_2 p_0 + \frac{1}{MN} \sum_{l=0}^{L-1} h_g(l) S(\mu(l)) \tag{5}$$

In this equation, $H_S(p_1, p_2)$ is the Shannon information measure of $\bar{I}$, the most closely common set with respect to $\bar{I}$. For $\bar{I}$ we have

$$\mu_{\bar{I}}(l_{mn}) = \begin{cases} 0 & \text{when } \mu_I(l_{mn}) < 0.5 \\ 0 \text{ or } 1 & \text{when } \mu_I(l_{mn}) = 0.5 \\ 1 & \text{when } \mu_I(l_{mn}) > 0.5 \end{cases} \tag{6}$$

Normally there are enough image elements for an image, and depending on the law of large numbers, it is not difficult to determine the probabilities p_1 and p_0 that the two element types $\mu_{\bar{I}} = 1$ and $\mu_{\bar{I}} = 0$ will appear in $\bar{I}$. Making the number of elements where $\mu_I > 0.5$ be m, the number where $\mu_I = 0.5$ be r, and the number where $\mu_I < 0.5$ be n then we have

$$p_1 = \frac{m + r/2}{m + r + n}, \qquad p_0 = \frac{m + r/2}{m + r + n}. \tag{7}$$

With regard to the image information measure we can make the following explanation. Image information measure contains two parts. One is the fuzzy information measure produced by the image equivalent fuzzy set I with respect to the fuzzy degree of its most closely common set, $\bar{I}$. The graduation a particular element in an image falls at a particular level between black and white. Correspondingly, the subordinate function of a particular element of the image equivalent fuzzy set can be any value in the interval [0,1], and is not just 0 or 1 (corresponding to the subordinate functions of black or white). Consequently, a certain indeterminacy is described by use of the image fuzzy entropy $H_f(\mu)$, that is to say $H_f(\mu)$ represents the fuzzy information measure of the image. Now that the indeterminacy caused by the internal fuzziness recounted here is removed, the fuzzy set of the image has become its most closely common set $\bar{I}$. In $\bar{I}$ only two kinds of elements exist (black or white), while another portion of the image information

measure H_{tot}--$H_s(p_1, p_0)$ depicts the Shannon information measure produced from the random nature of the two elements, black and white.

The Measure of Information Levels of Images Possessing Flat Histograms

In an image which possesses a flat histogram, $h_g(\ell)$ is a constant.

$$h_g(l) = MN/L \tag{8}$$

so

$$H_f(\mu) = \frac{1}{MN} h_g(l) \sum_{l=0}^{L-1} S(\mu(l)) = \frac{1}{L} \sum_{l=0}^{L-1} S(\mu(l)) \tag{9}$$

Because $h_g(\ell)$ is a constant and m = n in formula 7, consequently in the most closely common set $\bar{I}$, the probability p_1 that set elements $\mu_{\bar{I}} = 1$ appear and the probability p_0 that set elements $\mu_{\bar{I}} = 0$ appear are the same, moreover $p_1 = p_0 = \frac{1}{2}$. Because of this based on formula 5 we calculate:

$$H_{tot} = 1 + \frac{1}{L} \sum_{l=0}^{L-1} S(\mu(l)) \tag{10}$$

Figure 1 gives the curve relating the fuzzy entropy $H_f(\mu)$ of an image possessing a flat histogram and the gray level series L. The curve relating the normalized value $H_{tot}/H_{tot\ max}$ of the information measure of images possessing a flat histogram and the gray level series L is presented as curve (a) in Figure 2, and this curve is monotonically increasing. When the gray level series L is less than 3 bits the curve increases quickly. When L is greater than 3 bits the curve tends to level out. When L is 3 bits, the value $H_{tot}/H_{tot\ max}$ is larger than 0.90. When L is 7 bits, the value of $H_{tot}/H_{tot\ max}$ is larger than 0.99. When the value of L is a maximum, we get $H_{tot} \approx H_{tot\ max}$, $H_{tot\ max}$ being the information measure possessed by an image of gray continuum.

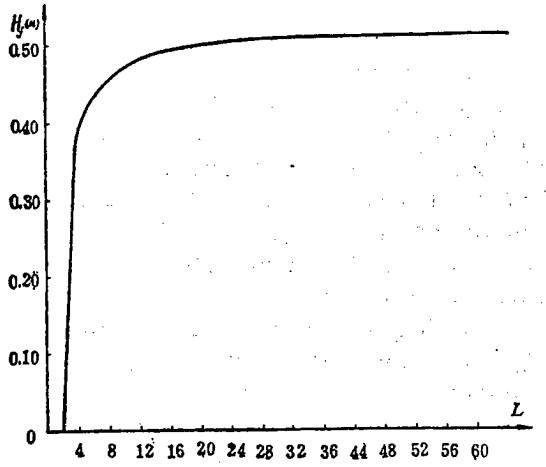

Figure 1. Relationship Between $H_f(\mu)$ and the Gray Level Scale L

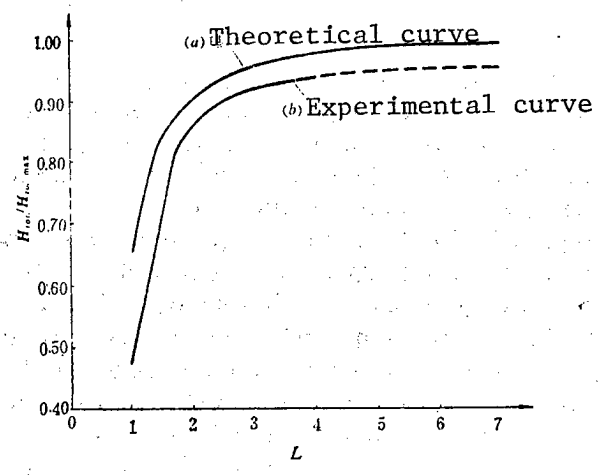

Figure 2. Relationship Between the Information of a Black and White Image and the Gray Level Scale L

Comparison of Theoretical Results With Experimental Results

The results represented in Figure 2 also reflect the experimental results extracted by Gaven, et al.,[6] with respect to black/white image information. The aim of their experiments was to obtain the functional relationship between information measure values of images which had undergone numerical processing and image gray level series. The images used in the experiments were equivalent squares, each image form had 45 scanning lines. The results of the experiment showed that with regard to images that had undergone quantized processing, peoples' level of precision in differentation and the gray level series were related as expressed in curve (b) of Figure 2.

The agreement between the theoretical curve (a) and the experimental curve is evident. Because the theoretical corresponds to the information measure of a static image the theoretical level is higher than the information level obtained from the scanned image elements and this is reasonable.

Practice in medical image processing[7] shows that in computer processed images of human blood cells, use of a 5 bit gray level scale is sufficient to reconstruct an image with an 8 bit gray level scale and yet maintain a sufficient information measure. The results of the theoretical calculations in this paper have without doubt completely explained this experimental result. This is because when L = 5 bits and L = 8 bits the difference in values of the corresponding $H_{tot}/H_{tot\ max}$ are not more than 1 percent. In medical ultra sound images, normally a gray level scale equal to or greater than 10 is used for which the corresponding $H_{tot}/H_{tot\ max}$ values are greater than 95 percent.

Additionally, when the gray level scale reaches 7 bits, $H_{tot}/H_{tot\ max} > 99$ percent then the image information measure that can be obtained is higher than 99 percent of the information measure of an image with continuous gray levels. This point is in accord with the experimental results of reference [8]. Those experiments pointed out that when the gray level scale is around 7 bits, processed images and the original image with continuous gray levels are extremely similar, to the degree that people cannot differentiate between them.

Conclusion

From the point of view of image information measure, in image processing, the application of 3-4 bit image gray level scales is capable of delivering an image of good quality and if an image of very high quality is desired the gray level scale used should be no lower than 7 bits.

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COMPUTER SYNTHESIZES TEXTURE WITH IDENTICAL MULTI-ORDER STATISTICS

Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 13 No 5, Sep 85 pp 102-107

[Article by Liao Mengyang [1675 1322 2254] of Wuhan University: "Computer Synthesizes Texture Having Identical Multi-order Statistics and Their Analysis"; received March 1984, revised September 1984]

[Text] Abstract: In terms of a computer vision system, this article discusses patterns with identical multi-order statistical characteristics. First, on the basis of the mathematical model proposed by B. Julesz, a computer was used to synthesize several types of different patterns with identical multi-order statistical characteristics. Then their special features were extracted and the pyramid method was used to differentiate and classify them with excellent results.

In actual contexts, human vision perception distinguishes objects by the use of pattern information and also brightness information. Using a computer to simulate the process of discrimination and classification of objects by the human vision system proceeds by detecting the differences in patterns. Their various special features are then utilized to perform differentiation and classification. For example, these techniques are used with respect to earth resources for rock formation analysis, geological analysis, and crop analysis of satellite pictures.[1]

Some people believe that the ability of the human vision system to distinguish patterns is based entirely on a difference of first or second order statistical characteristics inherent in patterns. Supposing different patterns with identical second or third order statistical characteristics. Can these be distinguished? In recent years this question has aroused interest in many scientists. The key to answering it lies in how to obtain different patterns with identical multi-order statistical characteristics. The test images in this article were produced by a computer vision system based on the mathematical model of different patterns with identical second and third order statistical characteristics proposed by B. Julesz.[2] First, the computer synthesized four different patterns with identical second order statistical characteristics. Finding the major unique characteristics which the individual patterns possessed and abstracting them, by applying methods based on a pyramid data construction, these abstracted unique characteristics were discriminated and classified providing excellent experimental results.

I. Synthesizing Patterns With the Same Second Order Statistical Characteristics and Differentiation and Classification

1. Production of different patterns with identical second order statistical characteristics

B. Julesz was the first to realize[3] that different patterns with identical second or third order statistical characteristics could not be distinguished by the human visual system. Soon afterwards, Pratt and Gagalowicz[4] and Julesz himself studied the question further, proposing a mathematical model to produce different patterns with identical second order statistical characteristics and proved that under certain special conditions the human vision system was capable of distinguishing different patterns with identical second order statistical characteristics. Based on these mathematical models, the author used a computer to generate various microdesigns (Figure 1(a), (b)) composed of 16 x 16 picture elements. By distributing these microdesigns in a fixed area, an image composed of 256 x 256 picture elements could contain many different patterns with identical second order statistical characteristics. (See Figure 2(a))

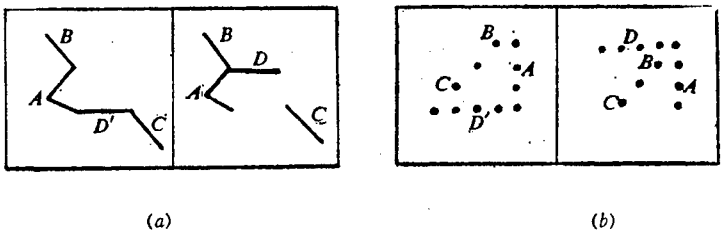


Figure 1. Continuous Microdesigns (a) and Discrete Microdesigns (b)

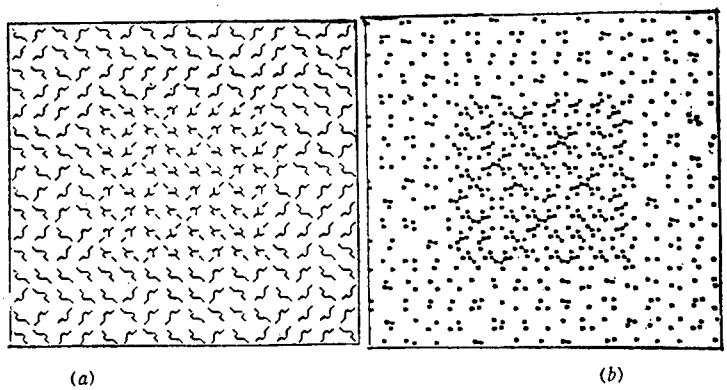


Figure 2. Continuous Original Pattern (a) and the Extracted End Point Characteristics (b)

2. Extraction of the special characteristics of patterns with identical second order statistical characteristics

In the analysis and differentiation of various patterns, first the major special characteristics of each pattern itself should be ascertained. Then one proceeds to design the special characteristics abstracted and finally to differentiate and classify the special characteristics which have been abstracted.

From Figure 1 we find that the major special characteristic among them is that in the different patterns the microdesigns have different numbers of end points. If we can detect the position and number of end points in the microdesigns in these patterns, this can provide valuable information for pattern differentiation and classification. The author designed a highly accurate and very simple operator for the position and number of two dimensional image end points detected:

$$P(m,n)=\begin{bmatrix} -1 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & -1 \end{bmatrix} \tag{1}$$

Using this and different image patterns G(i,j) with identical second order statistical characteristics, we undertake a convolution operation

$$\hat{G}(i,j)=\sum_{m=-1}^{1}\sum_{n=-1}^{1}P(m,n)G(i+m,j+n) \tag{2}$$

Then with the aid of a nonlinear filter, the position and number of the pattern end points $\hat{G}_p(i,j)$ can be picked out.

In order to ensure that the special characteristics of the end points $\hat{G}_p(i,j)$ selected are enhanced we use the following formula for processing:

$$\hat{G}_{EN}(i+k,j+l)=\hat{G}_p(i,j) \tag{3}$$

The values assigned to k and ℓ in the formula are 0, ±1. The original continuous pattern and the figure of the end point characteristics selected are shown in Figure 2(a) and (b), respectively.

The statistical values, based on actual measurements, before and after the processing of the two different patterns as described above are shown in Table 1. In the table, DOWN and UP represent the patterns composed by the microdesigns on the left and right sides of Figure 1(a).

Table 1. Measured Statistical Values

Measurement content and category / Measurement position	Mathematical Expectation		Variance		Entrophy	
	UP	DOWN	UP	DOWN	UP	DOWN
G (i,j)	4	4	991	991	0.1191	0.1191
$\hat{G}$ (i,j)	-37	-28	8,674	6,477	0.7748	0.6514
$\hat{G}_P$ (i,j)	0	0	243	0	0.0367	0.0655
$\hat{G}_{NP}$ (i,j)	43	34	8,944	7,455	0.6647	0.5802

3. Application of the data pyramid structure method to differentiation and classification

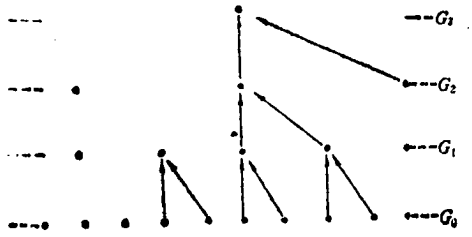
A pyramid data structure is one that takes the original image as the base level of a pyramid. If the size of the image base level is composed of 2^n times 2^n picture elements, then the sizes of higher level images are composed of 2^{n-1} times 2^{n-1}, 2^{n-2} times 2^{n-2}, ... 2 times 2, and 1 times 1 elements (picture elements). The size of the image at one level is one-fourth of that of the level below it. A single picture element at the nth level is comprised of the weights of many picture elements of the n-1th level. As the levels get higher, the image information of the original image contained in each picture element at that level increases. Consequently, the higher in the pyramid one processes the image the more integration is achieved. Because of the random relationship between their interlayer structure and among the elements on different layers, the pyramid structure provides a highly effective computational tool for the areas of computer vision systems, image detection, encoding, etc.

Introduced below are two kinds of pyramid methods which we adopted in experiments. Let G(i,j) represent a two dimensional image datum, 1 be the level of the pyramid structure, and w(m,n) be the weighting.

1. The formula of the data pyramid structure proposed by Tanimoto[6] is

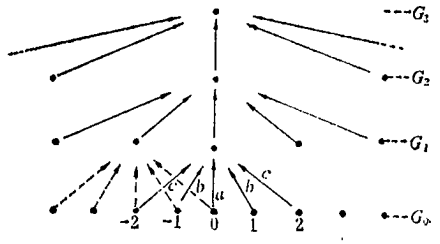
$$G_l(i,j)=\sum_{m=0}^{1}\sum_{n=0}^{1} w(m,n)\,G_{l-1}(2i-1+m,2j-1+n), \quad l\geqslant 1 \tag{4}$$

Figure 3 is a data structure schematic of this formula. Its particular feature is that there is no aliasing in the data structure. In two dimensional image data the value of each element from the higher level is weighted by the values of 2 x 2 elements of the lower level. For short we call it a 2 x 2 pyramid.



spacial position

Figure 3. Schematic of Tanimoto's Data Structure



spacial position

Figure 4. Schematic of Burt's Data Structure

2. The formula of the data structure proposed by Burt[7] is

$$G_l(i,\ j)=\sum_{m=-2}^{2}\sum_{n=-2}^{2} w(m,n)G_{l-1}(2i+m,\ 2j+n),\quad l\geqslant 1 \tag{5}$$

It deliberately causes the data structure to produce mixing to intensify the internal relationships in the data structure. A schematic of this one dimensional data structure is represented by Figure 4.

If the values of the weighted function w(m,n) are appropriately selected, the convolution of w with G_ℓ is nearly equal to the convolution of G_ℓ with the Gaussian function. Consequently, this is called a Gaussian pyramid. The image obtained by applying the convolution of formula (5) is equivalent to the result obtained by passing the original image through a low pass filter. The higher level image of the Gaussian pyramid can be conceived of as the result after the original image has been filtered level by level.

The reverse process to image reduction processing is image expansion. Due to the internal relationships between the levels present in the pyramid structure itself, it makes it so that the image which is processed in a smaller area at the higher levels can utilize certain mathematical relationships between levels, and expansion and enlargement can be carried out level by level. Actually, this is just following the process in Figure 4 in reverse. Supposing $G_{\ell,k}$ is obtained from the kth expansion of image G_ℓ, then

$$G_{l,0}(i,j)=G_l(i,j) \tag{6}$$

and

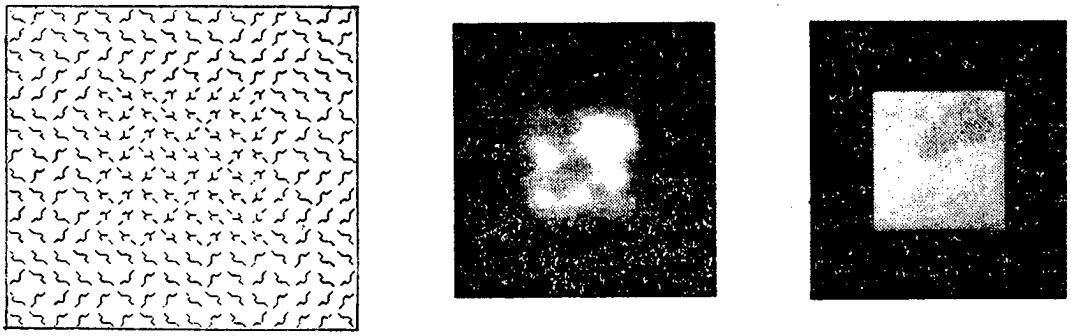
$$G_{l,k}(i,j)=\text{Expand}\{G_{l,k-1}\}$$
$$=4\sum_{m=-2}^{2}\sum_{n=-2}^{2} w(m,\ n)G_{l,k-1}\left(\frac{i+m}{2},\ \frac{i+n}{2}\right) \tag{7}$$

In the formula, only when (i + m)/2 and (j + n)/2 are integers do they contribute to the value of the sum. Note that $G_{\ell,1}$ and $G_{\ell-1}$ are images of the same size and $G_{\ell,1}$ is the same size as the original image.

When any image is enlarged 1 time, $2^{\ell-1}$ nodes are interpolated between every pair of image elements in an adjacent sample. It is equivalent to the interpolative function of the weighted function w(m,n).

With the pattern characteristics extracted from the original image (as shown in Figure 2(b)) we used the two calculation methods of data pyramids recounted above and proceeded with separate calculations on a computer. From the various level data structures obtained through calculation we found out the layers where the characteristics are differences of different pattern regions in the image were the clearest and stuck on a "label." Then with the application of some apriori knowledge distinguishing and classifying the different patterns in the image can be achieved. In order to make the size and position of the "label" and original size be in correspondence, we used formula (7) to enlarge the pattern of the upper level of the image to have the same size as the original image. Then using certain suitable technical processes we obtained the "labels" with different gray levels which corresponded to the different pattern regions.

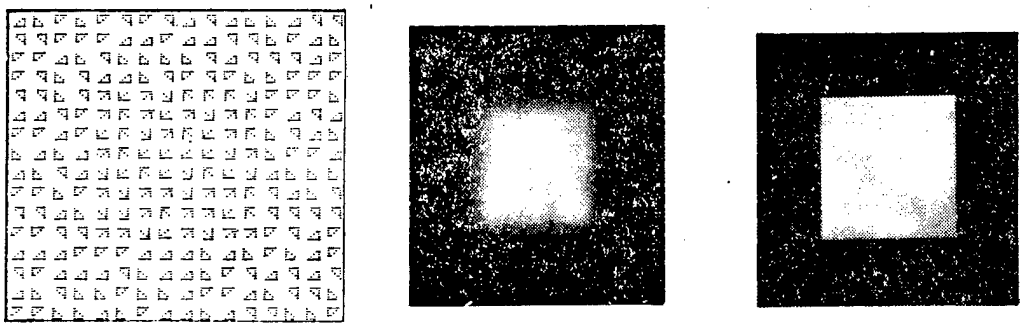
Figure 6(a) shows a pattern with identical, discrete second order statistical characteristics. It cannot directly use a continuous extracting type of characteristic extraction operator to carry out characteristic extraction from its original image because there is a fixed separation present between the image element points in the microdesign and the image elements. But a data pyramid structure method can be used where first layer structure processing of the original image is done to make the image elements of the microdesign in the second level be continuous. Then using the above method for analysis processing we can separately get the results as in Figure 6(b), (c).



(a) Original pattern (b) Gauss Pyramid Distinctions (c) 2 x 2 Dimensional Distinctions

Figure 5. Continuous Pattern Distinctions

As the above experimental results show, in an image which contains identical second order statistical characteristics but different patterns, these patterns can be differentiated very precisely with the use of a computer. Consequently this achieves the goal of simulating the human visual system process of distinguishing and classifying different patterns with identical multi-order statistical characteristics.



(a) Original pattern (b) Gauss Pyramid Distinctions (c) 2 x 2 Dimensional Distinctions

Figure 6. Discrete Pattern Distinction

II. Synthesis of Patterns With Identical Third-order Statistical Characteristics and Their Differentiation and Classification

Based on the model of patterns with identical third-order statistical characteristics proposed by Julesz,[8] we used a computer to synthesize odd and even kinds of different patterns with identical third-order statistical characteristics. By distributing them randomly in a flat image we formed an image pattern like that in Figure 7(a). After we found the major special characteristics of these patterns, we designed a very simple yet effective operator to extract the special characteristics of these patterns.

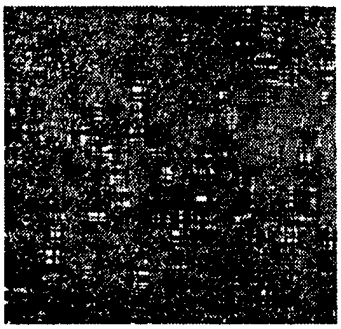
$$P(m,n)=\begin{bmatrix} 1/2 & -1/2 \\ -1/2 & 1/2 \end{bmatrix} \tag{8}$$

Using this with the operator to do convolutions of the original image pattern G(i,j)

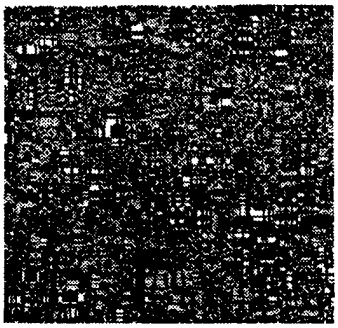
$$\hat{G}(i,j)=\sum_{m=0}^{1}\sum_{n=0}^{1}P(m,n)G(i+m,j+n) \tag{9}$$

the special characteristics of different patterns can be extracted. Then through some appropriate processing different patterns with identical third-order statistical characteristics can be distinguished and classified precisely as seen in Figure 7(b).

According to the latest theories studying vision properties, in the human visual system the process of information processing can be simulated by using a series of space frequency filters which have fixed bandwidths and orientation templates. On this basis the author engaged in measurement and differentiation of various different patterns with identical multi-order statistical characteristics and under conditions where matching was relatively good, the differentiation accuracy reached over 95 percent.[9] For various patterns with different first order statistical characteristics the differentiation accuracy reached 100 percent.[10]



(a) Odd, Even Mixed Pattern



(b) Extraction of Special Characteristics and Differentiation

Figure 7. Differentiation With Identical Third-order Statistical Characteristics But Different Patterns

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FOLLOWUP STUDY ON RADIATION EFFECT OF LOW-LEVEL γ-IRRADIATION ON 45 PERSONS

Beijing ZHONGHUA FANGSHE YIXUE YU FANGHU ZAZHI [CHINESE JOURNAL OF RADIOLOGICAL MEDICINE AND PROTECTION] in Chinese Vol 5 No 6, 25 Dec 85 pp 386-390, 453

[English abstract of article by Xu Xiufeng [1776 4423 7364], Wang Yongxiao [3769 3057 1321], Fang Yongxin [2455 3057 9515], et al., of the Laboratory of Industrial Hygiene, China National Center for Preventive Medicine, Beijing; paper received 11 July 1984]

[Text] Forty-five males once exposed to γ-irradiation at work were observed clinically and by biological method from 1966 through 1981. The doses ranged from 0.10 to 0.468 Gy. Neurasthenic syndromes were observed in all cases. Thirty cases of lens opacities were observed by slit lamp microscopy. There was one case of spontaneous abortion, one neonatal death, one strabismus, and one mental retardation among 37 children born to the irradiated subjects. There was one case whose wife failed to conceive since she married for 4 years. Analysis of chromosome aberrations and scoring of micronuclei in peripheral blood lymphocytes were statistically higher ($P<0.01$) than that of controls, but without linear relationships between doses and effects. The levels of serum immunoglobulin and serum follicular stimulating hormone were within normal limits. No cancer, or leukemia were detected by clinical examinations.

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